STRATEGIC OPTIONS FOR AZURE DYNAMICS IN HYBRID AND BATTERY ELECTRIC VEHICLE MARKETS

by

James Gordon Finlay
B. Sc. (Computer Science), University of British Columbia, 1981

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION

In the Management of Technology Program
of the
Faculty of Business Administration

SIMON FRASER UNIVERSITY

Fall 2012

Approval

Name: **James Gordon Finlay**

Degree: **Master of Business Administration**

Title of Project: **Strategic Options for Azure Dynamics in Hybrid and Battery Electric Vehicle Markets**

Supervisory Committee:

Dr. Pek-Hooi Soh
Senior Supervisor
Associate Professor
Faculty of Business Administration

Dr. Elicia Maine
Second Reader
Associate Professor
Faculty of Business Administration

Date Approved:

Abstract

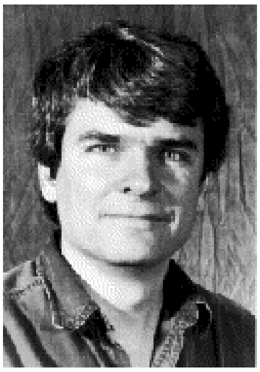
Azure Dynamics provides electric vehicle powertrain technology to commercial truck fleets in North America and Europe. Azure Dynamics is a firm in distress and fighting for survival, having filed for bankruptcy protection in March 2012.

An analysis of commercial trucking markets reviews factors driving vehicle electrification and provides a market segmentation to find segments best suited to Azure's technology. Porter's Five Forces methodology is used to assess target market attractiveness and to identify key success factors. An internal analysis of Azure employs a value chain and a VRIO model to identify core competencies. A strategic fit matches firm capabilities to the Differentiation Focus generic strategy. A performance assessment maps Azure's competitive position within light-duty and medium-duty truck market segments. Strategic options emerge from this analysis and are evaluated using a Balanced Scorecard.

From the analysis, the strategic option of selling Azure as a going concern is recommended. Ideally, the acquirer would be a firm with deep financial resources and a long-term vision. This option provides Azure with enough working capital to let it deal with product gross margin issues, and to eliminate use of equity financing to fund operating costs.

Keywords: Azure Dynamics; electric vehicle; hybrid vehicle; HEV; PHEV; BEV; battery; Truck; Powertrain; Outsourced Manufacturing; Fleet; Total Cost of Ownership; Incremental Cost; Payback; Porter Five Forces; Value Chain; VRIO; Core Competency; Strategic Fit; Generic Strategy; Differentiation Focus; Industry Attractiveness; Balanced Scorecard

Dedication



This thesis is dedicated to the memory of Dr. Tom Richardson, SFU Professor of Kinesiology, who was my close friend and mentor. Tom's inquisitive nature and passion for learning will continue to inspire me for the rest of my life. Tom, you are greatly missed.

Acknowledgements

I would like to express my sincere appreciation for my thesis supervisor Dr. Pek-Hooi Soh and my second reader Dr. Elicia Maine for their excellent comments and diligence in reviewing my thesis drafts. I would also like to thank Dr. Rick Colbourne for his help during the early stages of my thesis outline development.

I would also like to acknowledge the excellent support and encouragement of my project sponsors at Azure Dynamics in this endeavour. I am indebted in particular to Dr. Nigel Fitzpatrick, co-founder of Azure Dynamics for providing his expert background knowledge on the structure of the electric vehicle industry and the history of Azure Dynamics. My gratitude goes to Brad Oldham who helped with the review of my chapter on the value chain and core competencies of Azure Dynamics. Special thanks also go to the Azure management team including Ron Iacobelli, Stephen Lee, Jim Mancuso, Mike Elwood, and Nicolas Bouchon.

Last, but not least, I would like to acknowledge the constant support of my dear wife Lesley, whose love, patience and encouragement has kept me motivated throughout the program. Thanks also go to my daughters Elspeth and Alexis who encouraged this “fifty-something” student to pursue my dreams, and to my parents Jim and Aileen who instilled in me a yearning for the pursuit of further education and learning.

Table of Contents

List of Figures

List of Tables

Glossary

Term	Definition
AER	**All Electric Range** - The distance in miles or kilometres that a fully-charged PHEV can drive before needing to operate its engine
All-Electric Mode	See **Charge-Depleting Mode.**
ARRA	**American Recovery and Reinvestment Act.** Economic stimulus legislation enacted by the US government in February 2009. The primary objective of the act was to save and create jobs in response to the economic recession in the late 2000s. ARRA program elements include spending on reduced federal taxes, education, energy, infrastructure, health care, and unemployment benefits. The ARRA program budget was expected to be $831 billion USD. See http://www.recovery.gov/About/Pages/The_Act.aspx
BEV	**Battery Electric Vehicle** - A pure electric vehicle with no auxiliary internal combustion engine for propulsion (unlike a PHEV plug-in hybrid). It is propelled by an electric motor and uses the chemical energy stored in on-board batteries to power the motor.
Blended Mode	A mode of operation of a hybrid-electric vehicle involves the simultaneous use of an electric motor in conjunction with an internal combustion engine to power the vehicle's drivetrain.
BOM	**Bill of Materials** – A BOM is a list of the constituent parts, components, and sub-assemblies needed to manufacture a product. Manufacturing companies at various stages of a supply chain will use a BOM document to communicate required parts to their suppliers. BOM costs are one of three key elements of the cost of goods produced in the business. The others are direct labour costs and indirect overhead costs allocated to production (supervision, R&D, support, etc.).
CCAA	**Companies' Creditors Arrangement Act –** a Canadian legal statute that permits insolvent companies to restructure their business while providing short-term relief from meeting creditor obligations. The CCAA is similar to US Chapter 11 bankruptcy protection laws. See http://laws-lois.justice.gc.ca/eng/acts/C-36/.
COE	**Cab Over Engine** – Also known as a Cab-over truck, these commercial vehicles are typically tractor-trailer rigs in which the cab is located directly above the engine and the driver is sitting either atop the front wheels or slightly in-behind.
Charge-Depleting Mode	EVs and PHEVs operating in charge-depleting mode (also called All-electric mode or EV mode) are drawing all motive power and energy from the battery and reducing its state of charge. BEVs always operate in charge-depleting mode. PHEVs run in CD mode for the duration of the initial All Electric Range portion of the vehicle range when the internal combustion engine is not used.
Charge-Sustaining Mode	HEVs and PHEVs in charge-sustaining mode are supplementing battery power with another source of energy, most commonly from an on-board internal combustion engine used as a generator. The battery's state of charge is not being reduced. HEVs essentially always operate in charge-sustaining mode.
CV	**Commercial Vehicle** – Refers to vehicles used for business applications, typically trucks and vans. CVs can be used by government sector or corporate fleets, but they can also be used individually by owner-operators. In the European automotive industry, the term Commercial Vehicle is the preferred term to describe vehicles outside of the passenger vehicle sector while the term Truck is more commonly applied in North America.
Drivetrain	Also called a powertrain. a drivetrain is the set of components for transmitting power to a vehicle's wheels, including the engine, clutch, torque converter, transmission, driveshafts or axle shafts, U-joints, CV-joints, differential and axles.

Term	Definition
Electric Mile	For an electric vehicle, an electric mile is any mile in which the vehicle is propelled by an electric motor. For PHEVs or E-REVs, an electric mile is the total miles travelled multiplied by the percent of total power provided by electricity from the grid.
EM	**Electric Motor** - Transforms electrical energy into mechanical energy. In a grid-enabled vehicle, the electricity is supplied by the battery.
E-REV	**Extended-Range Electric Vehicle** - Sometimes called a series plug-in hybrid or a "Range Extender". E-REVs are electric drivetrain vehicles that rely on an electric motor to provide power to the drivetrain. The battery pack is supplemented by a generator set (powered by an internal combustion engine) to that supplies electricity to the electric motor or to the battery before it becomes depleted. The gasoline engine is not used to provide mechanical energy to the drivetrain.
EV	**Electric Vehicle** – a generic term for any type of electrified or grid-connected vehicle powered by an electric motor including plug-in hybrids (PHEVs), but it is more commonly used to refer to a pure Battery Electric Vehicle (BEV) that is propelled entirely by an electric motor without assistance from an internal combustion engine. The power comes in the form of current from an on-board storage battery, fuel cell, capacitor, photovoltaic array, or generator.
EV Mode	See **Charge-Depleting Mode.**
EVMT	**Electric Vehicle Miles Travelled** - The number of miles travelled in Charge-Depleting mode (solely on electric power) for a period of 1 year.
EVSE	**Electric Vehicle Supply Equipment** - The hardware of electric vehicle charging infrastructure, including public charging stations and wall- or pole-mounted home vehicle chargers or pedestals.
FCEV	**Fuel cell electric vehicle** – A vehicle that uses hydrogen fuel and an electrochemical fuel cell device to provide power to an electric motor. A typical fuel cell reaction requires the oxidation of hydrogen (aided by a proton-exchange membrane catalyst) to create electricity for the traction motor. The advantage of using a fuel cell is that the only by-product of the reaction is water. There are no carbon dioxide emissions (assuming that the hydrogen is prepared using electrolysis of water rather than by reforming fossil fuels such as methanol or natural gas). Lack of hydrogen generation and storage facilities and refuelling infrastructure is a major disadvantage.
Full Hybrid	A type of hybrid electric vehicle (HEV) that has sufficient battery capacity to operate for a limited time in all-electric mode while driving at slow speeds. Full hybrids can achieve increases in vehicle range of 25 to 40 percent.
Generator	Converts mechanical energy from an engine into electrical energy.
GEV	**Grid-enabled Vehicle** – A battery electric vehicle or plug-in hybrid-electric vehicle that can be connected directly into the electric grid to recharge on-board batteries.
GHG	**Green-House Gases**, Atmospheric gases from a vehicle exhaust such as carbon dioxide (CO2) or nitrous oxide (NO2) which permits incoming sunlight to penetrate the earth's atmosphere but absorbs the heat that is radiated back from the surface of the earth (the greenhouse effect).
GVW	**Gross Vehicle Weight -** The maximum operating weight of a vehicle including the body, engine, chassis frame, fuel, driver, and passengers and cargo load. The term is used to categorize commercial vehicles according to various weight classification schemes.
HCV	**Heavy-duty Commercial Vehicle** – Any Class 6 to Class 8 heavy-duty truck (such as a beverage truck, cement mixer, dump truck, refuse truck, or line haul freight truck) with gross vehicle weight (GVW) greater than 19500 lbs. that is used for commercial

Term	Definition
	applications.
HEV	**Hybrid Electric Vehicle**. HEVs use an electric motor as a secondary power source to supplement the primary internal combustion engine power source. Both power sources are connected to the drivetrain in either a series or parallel configuration. HEVs support regenerative braking, a method which employs the electric motor in reverse to convert mechanical energy from the brakes back to electricity to recharge the battery pack. HEVs use conventional gasoline or diesel fuel.
HHV	**Hybrid Hydraulic Vehicle –** HHVs use a hydraulic transmission to deliver power to the vehicle wheels. An internal combustion engine as the primary energy source, but is supplemented by an accumulator system that stores energy in highly pressurized fluid reservoir.
ICE	**Internal Combustion Engine**. A gasoline or diesel power plant that produces power by combining liquid fuel and air at high temperature and pressure in a combustion chamber, using the resulting gas expansion for mechanical energy. ICE power plants can use either a two-stroke or a four-stroke combustion cycle.
kW	**Kilowatt** – A unit of power equivalent to 1000 watts, 1000 joules per second or about 1.34 horsepower.
kWh	**Kilowatt-hour** – A unit of energy or work defined as the amount of energy released if work is done at a constant rate of 1 kW for 1 hour, equivalent to 3.6 megajoules. A value expressed in kWh is often used to indicate the amount of battery capacity.
LCV	**Light-duty Commercial Vehicle** – Any Class 2 or Class 3 light-duty truck (such as a mini-van, full-size van or small postal van) with gross vehicle weight (GVW) less than 14000 pounds that is used for commercial applications.
Li-Ion	**Lithium-Ion** – A rechargeable battery chemistry innovation in which lithium ions move from the cathode to the anode during discharge, and in the reverse direction during charging. Advantages of Lithium Ion batteries relative to NiCad and NiMH chemistries include superior performance in cold weather, exceptional energy density, increased number of charge cycles, and faster charge times (minimizing vehicle down time). Disadvantages include cost, potential safety issues (thermal issues if the batteries are short-circuited for any reason), and battery lifetime limitations due to increasing internal resistance over time.
Li-Poly	**Lithium-ion polymer** – A battery chemistry that is similar to a lithium-ion battery formulation. However, in a Li-Poly or LiPo battery the lithium-based electrolyte is a solid polymer composite (e.g. polyethylene oxide) rather than an organic solvent. The advantages of the solid polymer-based electrolyte vs traditional solvent-based li-ion battery chemistries are lower cost, and adaptability to various shapes. Disadvantages are lower energy density than standard Li-ion chemistries.
MCV	**Medium-duty Commercial Vehicle** – Any Class 4 or Class 5 medium-duty truck, large walk-in van (step van), parcel delivery truck, utility boom truck, or shuttle bus with gross vehicle weight (GVW) from 14001 to 19500 lbs. that is used for commercial applications.
NHTSA	**National Highway Traffic Safety Administration** - A US government agency (under the auspices of the Department of Transportation) that oversees motor vehicle and highway safety. NHTSA is responsible for implementing safety performance standards for motor vehicles and transportation equipment in an effort to reduce human injuries and fatalities, and their associated economic costs. See http://www.nhtsa.gov/
NiMH	**Nickel metal hydride** – A rechargeable battery chemistry that is similar to the older generation of rechargeable NiCad (nickel cadmium) batteries. NiMH batteries use a less toxic hydride alloy for the anode, whereas the NiCad batteries use a cadmium anode.

Term	Definition
	One of the main advantages of NiMH batteries is that they possess an energy density which is three times greater than that NiCads and almost as good as the latest Li-Ion technology. However, unlike Li-Ion battery chemistry, NiMH batteries have a shorter lifetime (low maximum number of charge cycles) and poorer cold temperature performance.
NOx	NOx is a name given to NO (nitric oxide) and NO2 (nitrogen dioxide) gases which are air pollutants formed by the combustion of gasoline with nitrogen and oxygen in the air. NOx-related air pollution can be a significant problem in dense urban communities with heavy vehicular traffic levels.
OEM	**Original Equipment Manufacturer** - A company that produces a product designed for the end user, whether a consumer or another manufacturing firm. In the automotive industry, an automotive OEM is usually a Tier 1 manufacturer that sells vehicles to consumers and commercial customers, typically through a dealer network; however, a battery OEM may sell batteries only directly to automotive manufacturers.
Parallel Hybrid	Hybrids that have an IC engine and electric motor which both provide torque to the wheels. The extra power from an auxiliary electric motor system is used to augment the power from the IC engine (the primary drive system). Some parallel hybrids can run in all-electric mode (see PHEV).
Peak Demand	The greatest electricity demand that occurs during a specified period of time.
PHEV	**Plug-in hybrid electric vehicle** – A sub-category of hybrid-electric vehicles (HEV) which use larger batteries to allow the vehicle to be driven for longer periods of time in all-electric mode rather than hybrid mode (power from both an electric motor and an IC engine). Relative to a standard HEV vehicle, a PHEV is more energy-efficient. PHEV batteries can be recharged by connecting the on-board vehicle charger to a charging pedestal. Sometimes a suffix is appended to the PHEV acronym to indicate the All Electric Range (AER) of the PHEV. For instance, PHEV-10 means a PHEV with a 10-mile AER, and PHEV-40 would mean a vehicle with a 40-mile AER.
Power Inverter	A power electronic conversion device which takes a DC direct current input and converts it into an AC alternating current output. This process is the opposite of a rectifier, which converts AC into DC.
Powertrain	See Drivetrain.
Residual Battery Value	The value of a battery established by the market after it has completed its primary purpose service life.
Series Hybrid	A type of HEV vehicle which makes use of both IC engine and electric motor. Unlike the parallel hybrid, the series hybrid uses only power from the electric motor to deliver torque to the wheels. The IC engine power source is used only as an on-board recharging system.
SISP	**Sale and Investor Solicitation Process** – A restructuring procedure for selling a firm to prospective investors. The SISP process is used for debtor companies which have entered creditor protection under CCAA legislation in Canada. The SISP steps include the way the company publically advertises the investment and purchase opportunity, the manner in which prospective bidders may have access to due diligence materials, the manner in which these bidders become qualified, the process for selection of one or more successful bids, and the subsequent court approval of the sale of the firm.
TCE	**Transit Connect™ Electric** – Azure Dynamics' battery electric vehicle (BEV) adaptation of the Ford Transit Connect™ light-duty van platform. For this derivative, Azure integrates engineless Ford Transit Connect vans (referred to as "gliders") with Azure's Force Drive™ electric powertrain and a 28kWh Johnson Controls lithium-ion battery-pack.

Term	Definition
TCO	**Total Cost of Ownership** - A measure of the entire undiscounted cost associated with the purchase, maintenance, usage, and disposal of a product spread evenly over the expected service life.
VIO	**Vehicles In Operation** – Refers to the cumulative total number of vehicles still in use (sometimes referred to as the installed base of vehicles) or the total size of the vehicle fleet (usually measured within a defined geographic region or a segment of the automotive industry).
VKT	**Vehicle Kilometres Travelled** –The number of kilometres travelled nationally by vehicles for a period of 1 year. A metric alternative to VMT commonly used in Europe
VMT	**Vehicle Miles Travelled** - The number of miles travelled nationally by vehicles for a period of 1 year.
xEV	**Electric Drive Vehicle** - An inclusive term that collectively refers to all vehicles that incorporate some form of battery electric power in the drivetrain. Includes hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), Extended-range Electric Vehicles (EREVs), and battery electric vehicles (BEVs).
ZEV	**Zero-emission Electric Vehicle** – A less common alternative term for a Battery Electric Vehicle (BEV).

1 Introduction

This thesis assesses the strategic options for Azure Dynamics within various commercial truck segments of the automotive industry. The strategic challenges facing the firm have changed considerably during the preparation of this report. On March 26th 2012, Azure Dynamics became insolvent and filed for bankruptcy protection under the Companies' Creditors Arrangement Act (CCAA) in the British Columbia Supreme Court while it attempts restructuring. This cash-flow distress was caused by an unexpected shortfall in 2011 sales revenue versus forecast, and by unanticipated difficulties in raising capital through public share offerings and private placements to finance operations. Azure closed three of its four offices, and laid-off 120 of 160 members of its staff. As a result, Azure's core resources and capabilities have changed considerably. Pending new investment, Azure has constraints on its liquidity, its capability to operate as a going concern, to seek new fleet customers, to support existing customers, and the extent to which it can continue to engage in engineering and new product development.

The report starts with a detailed analysis of the market demand for Hybrid Electric Vehicle (HEV) and Battery Electric Vehicle (BEV) powertrain technology within these segments. It provides an internal analysis and review of Azure's core capabilities and potential to penetrate these segments (assuming Azure's capabilities pre-insolvency). Finally, the last chapter of the report contains a strategic analysis of the options for restructuring Azure post-insolvency and considers the valuation of Azure's product designs, its human resources, and its intellectual capital. Options and recommendations will be made – e.g. perhaps to re-emerge as an independent engineering design bureau, to be absorbed into the engineering team of another automotive firm, to be liquidated at auction, etc..

Where necessary, any facts or figures concerning Azure Dynamics shall make it clear whether they related to Azure during the "pre-insolvency" period, the "post-insolvency" period, or in some cases at both times. For instance, certain sections deal with Azure's state of affairs both before and after (e.g. section 4.3 on Core Competencies and section 5 on Financial Performance).

1.1 Azure Dynamics Corporate Background

Azure Dynamics (AZD) is a leading designer and supplier of Hybrid-Electric Vehicle (HEV) and Electric Vehicle (EV) powertrain systems and controls for customers in the light-duty to heavy-duty truck segments of the automotive industry. Azure Dynamics has recognised expertise in the design of HEV and EV powertrain systems (described in section 2.2 on Enabling Technology – Vehicle Electrification Alternatives) particularly in the areas of power electronic control software, systems engineering and vehicle integration. These core systems capabilities are supplemented by additional skills in the design of proprietary electric drive component products including AC inverter and electric drive assemblies.

1.1.1 Company Mission, Vision and Competitive Advantages

The mission of Azure Dynamics is "***Driving a World of Difference***". As its enduring purpose, Azure strives to make a difference in the world by helping fleet customers deploy environmentally friendly vehicles – vehicles that will lower CO_2 emissions and reduce the carbon footprint, and reduce the economic dependence on fossil fuels.

The Azure Dynamics vision in support of this mission is "***To be the world leader in providing hybrid-electric (HEV) and all-electric (BEV) powertrains and control systems for the light to medium duty commercial vehicle markets***".

Azure strives to achieve this vision by leveraging what it believes to be competitive advantages in three areas:

1. **Best People** – Recruit the best people available to bring their breadth of knowledge, skills and experience to each role at Azure Dynamics including:
   - Engineers with a passion for developing innovative alternative energy solutions
   - Technical support personnel who are dedicated to creating positive customer relationships
   - Sales representatives with the determination to deliver success with channel partners
   - Executives with veteran leadership in the automotive industry and a forward-looking vision

2. **Best Partners** - Azure forms alliances with partners who will help to get Azure technology on the road. Azure seeks to align itself with world-class OEM partners like Ford, and Tier 1 component suppliers like Johnson Controls who help to demonstrate the superiority of Azure Dynamics powertrain solutions to North American and European fleet customers.

3. **Best Technology –** Azure uses proven technology as a competitive advantage. Over 10 years, Azure hybrid electric and all-electric powertrains have logged more than 56 million kilometres on the road. On-going efforts are made to optimize Azure hybrid and electric powertrain systems. For example, in 2011 Azure delivered the second-generation of Azure's Balance™ hybrid vehicle platform, adding a long-life lithium-ion battery from Johnson Controls, and a front-end auxiliary drive design. These improvements benefit Azure by reducing bill of material costs and benefit fleet customers by improving efficiency and durability (Figure 1).

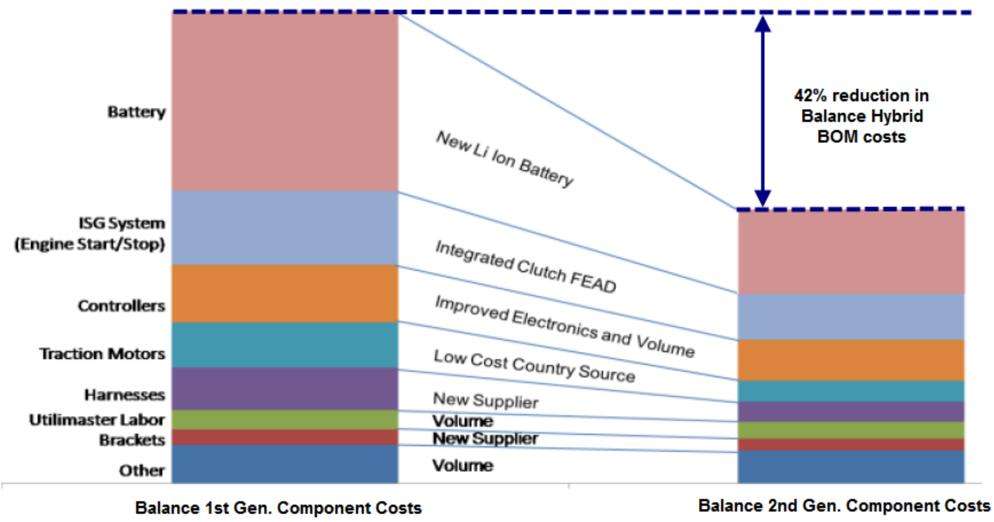


Figure 1 - Second Generation Balance Hybrid Powertrain Cost Reductions Source Data: Adapted from internal Azure Dynamic documents

1.1.2 Existing Product Lines

Azure has three primary product lines including:

- Battery Electric Vehicles (BEVs) - e.g. Ford Transit Connect Electric light-duty van
- Hybrid Electric Vehicles (HEVs) – e.g. Balance™ Hybrid Electric van and shuttle Bus products
- Force Drive™ line of powertrain components including traction motors, digital motor controllers, inverters and DC-DC controllers.

The Product Customer Matrix (PCM) in Table 1 provides an overview of the customer market segments that are served by each of these three product lines.

Products	**Customer Market**														
	Class 1-2 Light-duty Commercial Vehicles (LCV)				**Class 3-5 Medium-duty Commercial Vehicles (MCV)**					**Heavy-duty Commercial Vehicles (HCV)**					**Buses**
	Urban Delivery	**Facilities Management**	**Trades and Services**	**Postal Delivery**	**Logistics**	**Home Delivery**	**Parcel Delivery Step Vans**	**Utility / Telecom Service Vehicles**	**Shuttle buses**	**Class 8 Freight Line haul Sleeper Cabs**	**Waste Refuse Collection**	**Day Cab Freight Trucks and Beverage Trucks**	**Refrigeration**	**Mining and Construction**	**Transit Buses, Motor Coaches, School Buses**
Battery Electric Vehicles (BEVs)															
- Transit Connect Electric Van	X	X	X	X											
Hybrid Electric Vehicles (HEV)															
- Balance Hybrid Electric Step Van					X	X	X	X							
- Balance Hybrid Electric Shuttle Bus									X						
Force Drive™ Power-train Kits and Electric Drive Sub-components															
- AC55 with DMOC445	X	X	X	X											
- AC90 with DMOC645					X	X	X								
- DC-DC Converter Model 750	X	X	X	X	X	X	X	X	X	X	X	X	X		

Table 1 - Azure Dynamics Product Customer Matrix

The target markets for Azure's proprietary electric and hybrid vehicle solutions include parcel delivery, postal, courier and shuttle-bus applications for light- and medium-duty commercial vehicle fleets in North America and Europe. These vehicles have some of the least efficient drive cycles. They have high rates of utilization over a 24-hour period while operating on routine routes and parking only overnight. They start and stop frequently, and use considerable amounts of fuel.

In 2011, sales of the Force Drive powertrain component products (as separate unbundled products) were discontinued to low-volume aftermarket car segments (e.g. EV hobbyists), but continue to be developed as critical components within Azure Dynamics own vehicle designs as well as for larger OEM customers with electric drive requirements. Development and testing of powertrain technologies has been Azure's primary focus since it was founded in 1997. Azure's hybrid-electric trucks have been in full-scale production since 2007. All platforms generated a combined total of $34 million of revenue in 2011.

Truck Classification by Duty Class of Vehicle is covered later under commercial truck market segmentation in section 2.6.1 while Appendix B provides a Background to Hybrid Electric and Full Electric Vehicle technologies.

Prior to insolvency, the Balance Hybrid Electric was sold only in North America while the Transit Connect Electric was sold in both North America and Europe. Vehicles were sold through selected dealers and channel partners.[1]

1.1.2.1 Balance™ Hybrid Electric Step-Van and Shuttle Bus

The Balance™ parallel hybrid platform is aimed at medium duty class 4-6 applications (10,000 to 19,000 lbs. GVW) including parcel delivery walk-in vans ("step vans"), postal vans, and shuttle buses. Figure 2 and Figure 3 show images of the product in delivery van and shuttle bus configurations respectively. Since the Balance Hybrid Electric Vehicle (HEV) product line began commercial production in 2008, approximately 1470 Balance vehicles have been sold.

---

[1] Note that production of the Azure Dynamics Transit Connect Electric van and the Balance Hybrid Electric delivery vehicles and Balance shuttle buses were halted (on what was expected at that time to be a temporary basis) as a result of the CCAA Bankruptcy proceedings that commenced in May 2012. Interim managers of Azure Dynamics had hoped that the company would be sold during reorganization via a bidding procedure or Sales and Investor Solicitation Process (SISP). Any sales transaction which would have allowed Azure Dynamics to continue as a going concern failed to materialize and production did not resume by August 2012. On July 27th 2012, all Azure patents were sold to Mosaid Technologies, a Canadian patent licensing and intellectual property development company. All remaining assets of Azure were scheduled to be liquidated in a claims process starting on October 18th, 2012 (Supreme Court of British Columbia, 2012).

Figure 2 - Azure Dynamics Balance Hybrid Electric Delivery Van (as used by Purolator)
Source: Azure Dynamics

Figure 3 - Azure Dynamics Balance Hybrid Electric Shuttle Bus
Source: Azure Dynamics

Parallel hybrid technology is more conducive to urban vehicles that also need to operate on highways for extended periods. Because of a partnership agreement with Ford, Azure's Balance™ hybrid-electric platform is based on adapting and electrifying Ford's E-350 and E-450 truck chassis. Azure's Balance Hybrid-electric shuttle buses have received durability certification at the NHTSA Altoona proving ground. As a result, US public transit agencies purchasing the Balance platform can qualify for Federal Transit Authority assistance. Azure's Balance platform has also received California Air Resources Board (CARB) and EPA certifications, making the vehicle eligible for subsidies under the Hybrid Truck and Bus Voucher Incentive Program. Fleet purchasers of Azure hybrid trucks or buses can qualify for HVIP vouchers and rebates of up to $25,000.

1.1.2.2 Transit Connect Electric (TCE) Light-Duty Panel Van

In 2009, Azure developed the Transit Connect Electric (TCE) vehicle platform with assistance from Ford. The TCE is an all-electric BEV version of the Ford Transit Connect™ van, which was designed initially for United States and Canadian markets. Ford agreed to supply Azure with Transit Connect "glider" vans (complete vans without the gasoline engine, fuel tank and exhaust system) which are then integrated with Azure's Force Drive™ electric powertrain and a 28kWh

Johnson Controls lithium-ion battery-pack. Azure sells the TCE vans to fleets through Ford's dealer network. Figure 4 displays an image of the TCE van.

Figure 4 - Azure/Ford Transit Connect Electric light-duty panel van
Source: Azure Dynamics

Since the Transit Connect Electric (TCE) product line began commercial production in 2010, approximately 530 TCE vehicles have been sold. Lead customers for the TCE van include Xcel Energy, DHL, AT&T, and the New York Power Authority. In North America, more than 70 Ford dealerships have already signed distribution agreements with Azure to provide sales and service of the TCE. In 2011, Azure expanded to the European market and completed several dealer agreements there. More than 100 TCE vehicles have been sold in Norway including a large sale to Norway's postal authority.

1.1.2.3 Force Drive™ electric vehicle systems and components

Azure also designs and manufactures the ForceDrive™ product line of electric drive components and electric vehicle controls including high-power inverters, AC induction motors, DC-DC converters, and electronic controller systems. Electric powertrain kits and complete AC traction motor drive assemblies are sold to both OEM and aftermarket customers for vehicle electrification and conversions. Azure Dynamics is to some extent vertically-integrated since its own ForceDrive™ electronic components are used in Azure vehicle designs and systems including the Balance™ hybrid-electric walk-in delivery van, the all-electric Transit Connect Electric van, and the LEEP mild-hybrid auxiliary power systems. In 2010, Azure Dynamics collected $1.4 million sales revenue from delivery of Force Drive™ electric vehicle systems and components.

1.1.3 Corporate Structure

Prior to the recent insolvency, Azure traded on the TSX Exchange (TSX: AZD) as a Canadian public company and on the Over-The-Counter market (OTC: AZDDF) in the US. As of December 2011, Azure had 160 employees located at its corporate head office in Detroit Michigan with additional offices and facilities located in Vancouver, Boston, Toronto, and Stevenage (UK). Figure 5 shows the corporate structure of Azure Dynamics including the subsidiaries in Canada, USA, and UK as well as their respective office facilities. Post-insolvency, Azure now has about 30 employees, mainly design engineering staff located at the sole remaining facility in Vancouver. Azure has recently been delisted from the TSX exchange.

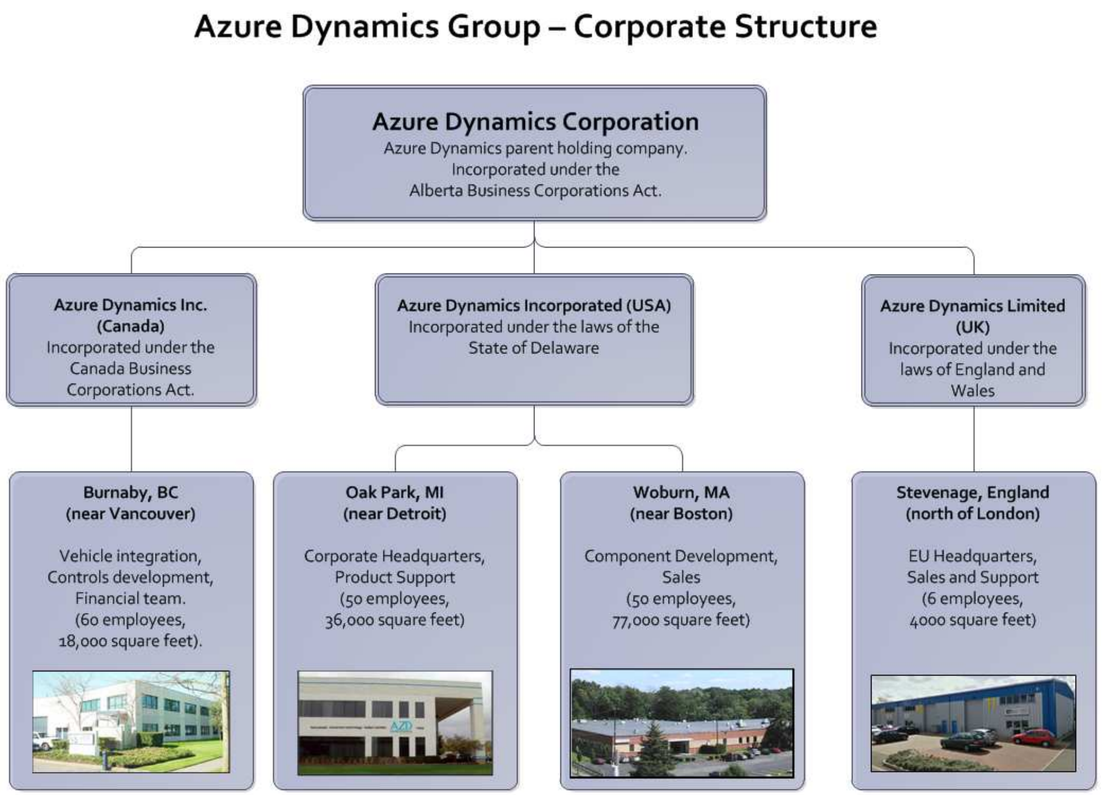


Figure 5 - Azure Dynamics Group - Corporate Structure

This group of firms operate as a highly integrated global enterprise, with financing provided by Azure (the public company parent) and operations conducted through its three subsidiaries. The principal operating subsidiary Azure Canada is based in Burnaby, British Columbia and provides all financial management and new product research and development functions for Azure Dynamics.

1.1.4 Azure Dynamics History

Azure Dynamics entered the market for development of hybrid-electric powertrain systems in 1999 as a spin-off of BC Research Inc. (BCRI), a Vancouver-based technology incubator and consulting company. BCRI originally commenced applied research and development of hybrid electric technology in 1993 under the direction of Dr. Nigel Fitzpatrick. Azure Dynamics Inc. was incorporated in 1997. It went public in 2001 via a reverse takeover of an inactive public company named Wild Horse Resources Ltd. Azure was listed on the TSX Venture Exchange. The resulting firm was renamed Azure Dynamics Corporation.

For the first 10 years after incorporation in 1997, Azure developed and tested its hybrid-electric and battery-electric powertrain technologies for demonstration prototypes and a few limited-scale customer deliveries. In 2007, Azure ramped up delivery of product shipments to larger fleet customers, and started to generate commercial revenues. A summary of important milestone in Azure Dynamics history is shown in Figure 6.

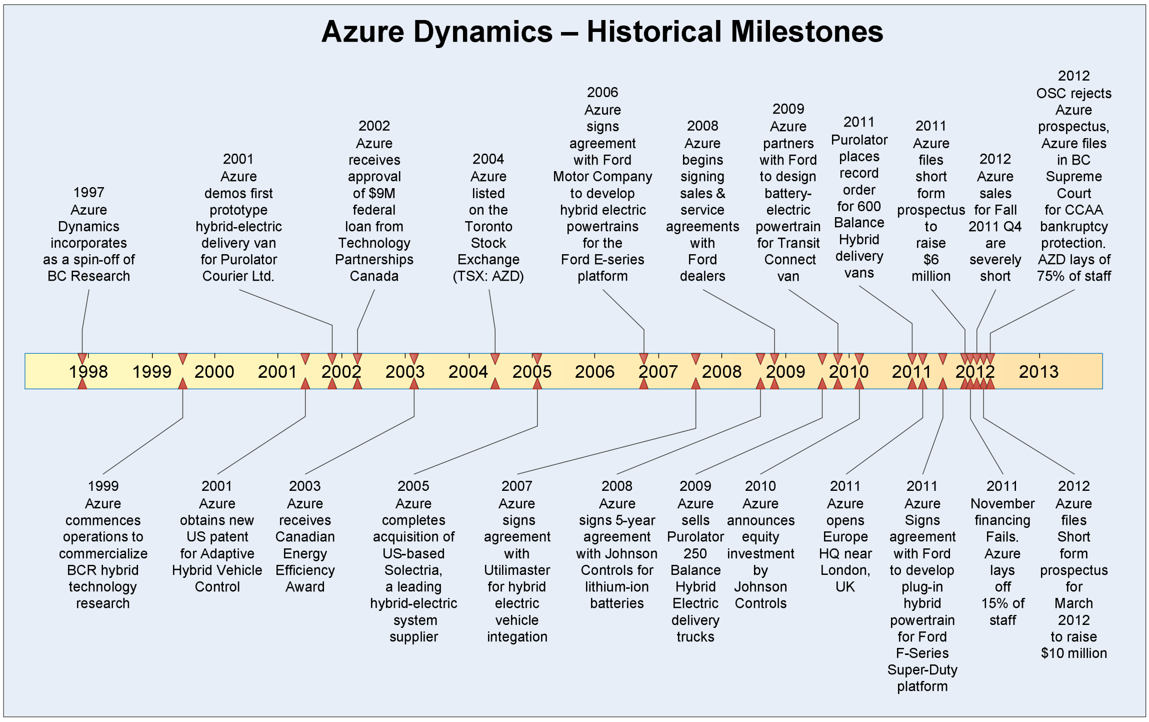


Figure 6 - Azure Dynamics Historical Milestones

A more-detailed chronology of the major events in the history of Azure Dynamics since incorporation is provided in Table 2.

Table 2 - Chronology of Azure Dynamics Historical Events

Year	Description of Event
1994	BC Research, a Vancouver-based technology incubator company commences research into hybrid electric technology. The first US patent of Azure's technology is issued in 1995.
1997	Azure Dynamics incorporates December 1997 as a spin-off of BC Research.
1999	Azure Dynamics commences operations to commercialize the BCR systems technology
2001	Azure Dynamics Inc. completes a reverse takeover of Wild Horse Resources. The public company is renamed Azure Dynamics Corporation, and facilitates access to capital in future financings.
2001	Azure Dynamics demonstrates the first prototype hybrid electric step van for Purolator Courier Ltd.
2002	Azure Dynamics receives $9M R & D investment from Technology Partnerships Canada
2003	Azure demonstrates a second generation prototype with Purolator Courier which leads to an order for 30 preproduction vehicles and potential supply of up to 2,000 vehicles
2004	Azure completes development of two series hybrid-electric truck platforms: G1 for medium-duty commercial vehicles and G2 for light-duty commercial vehicles (for Canada Post).
2004	Azure moves headquarters to a new 18,000 sq. ft. facility in Burnaby, BC.
2004	Azure Dynamics Listed on the Toronto Stock Exchange (TSX: AZD).
2005	Azure Dynamics completes the acquisition of Boston-based Solectria, a leading US hybrid electric system supplier. Solectria engineering resources provide Azure with parallel hybrid electric drive components and a US based of operations at a 77,000 sq. ft. engineering facility near Boston, MA.
2005	Azure designs Hybrid Senator HD shuttle bus prototype on G1 platform for StarTrans.
2005	Purolator orders 115 series hybrid electric vehicles for their Toronto hybrid electric fleet.
2006	Azure signs deal with Ford to develop the Balance P1 hybrid electric powertrain for the Ford E-450 series trucks. The deal gives Azure access to Ford distribution network for sales and service.
2006	Azure develops prototype Low Emission Electric Power mild-hybrid auxiliary power system for Kidron.
2007	Azure Dynamics signs supply agreement with truck body builder Utilimaster to integrate new Balance P1 parallel hybrid powertrain design with Utilimaster Step Van.
2007	After positive field trials, Purolator orders 105 Balance P1 parallel hybrid delivery vans.
2007	Scott Harrison appointed CEO to help Azure make transition to commercial production.
2007	Azure moves corporate head office to a new development center in Oak Park, Michigan near Detroit. The facility is in proximity to Azure's key industry partners, including Ford Motor Company.
2007	Azure signs an agreement with Federal Express ("FedEx") to demonstrate 20 Balance parallel hybrid Ford E450 delivery trucks. The first vehicle is delivered to FedEx in November of 2007.
2008	Azure Dynamics' Balance Hybrid Shuttle Bus obtains US certification at the Altoona proving ground.
2009	In January, the global recession and challenging economy causes Azure to lay off 25% of its staff. Azure decides to focus on existing core products and cancels new programs (e.g. P2 heavy-duty hybrid).
2009	Azure Dynamics signs 5 year Supply Agreement with Johnson Controls-Saft for Lithium-Ion batteries.
2009	Azure launches the Balance Shuttle Bus version of the P1 platform. Collins Bus Corporation agrees to provide the Azure Balance hybrid powertrain as an option for their Type A school buses.
2009	Azure sells Purolator 250 Balance Hybrid Electric delivery trucks, Azure's largest order as of 2009.
2009	Azure obtains $10 million financing in August, and another $30 million in December 2009.
2009	FedEx purchases an addition 51 Balance hybrid delivery vehicles.
2009	Azure signs agreement with Ford to develop and produce a pure-electric powertrain based on Azure Force Drive™ technology for the Ford Transit Connect Electric van. AT&T is the first lead customer.
2010	In February, Azure and Ford introduce the Transit Connect Electric van at the Detroit Auto Show. The Transit Connect Electric receives the 2010 North American Truck of the Year award.
2010	Azure Dynamics selects AM General for Transit Connect Electric up-fitting in North America.
2010	Azure Dynamics announces strategic investment by Johnson Controls.
2010	Azure Dynamics Balance™ Hybrid Electric technology approved for California Incentive Funding.

Year	Description of Event
Jan. 2011	Purolator places record order for 600 Balance Hybrid vans over next three years.
Jan. 2011	Azure announced order from DHL Courier for 50 Balance Hybrid Electric vans for their New York fleet.
Mar. 2011	Azure Dynamics opens European Headquarters in North London.
Mar. 2011	Azure Dynamics selects Lotus Lightweight Structures for Transit Connect Electric up-fitting in Europe.
April 2011	Azure Dynamics' management and board begin to explore business opportunities in China for Azure Dynamics' electric vehicle technologies and engage financial advisors and consultants to this end.
June 2011	Azure announces intent to list shares on NASDAQ exchange. Azure plans a share consolidation. Azure intended to raise $75 million to execute growth plan for 2013 and beyond.
July 2011	Azure signs deal with Ford to integrate its plug-in hybrid technology on Ford's market leading F-Series Super Duty cab and chassis, the F-550, with production expected in early 2013.
August 2011	Norwegian Post becomes the first European customer for the Transit Connect Electric. Azure announces sale of 100 Transit Connect Electric vans to Røhne-Selmer, a Norwegian Ford dealership.
September 2011	Weak global capital markets and sovereign debt crisis in Europe causes Azure to abandon plans to raise capital on the NASDAQ listing. Azure decides to pursue alternative financing options.
Nov. 2011	Azure completes a private placement with Johnson Controls to raise $5.1 Million.
November 2011	Azure files a short form prospectus to attempt to raise $6 Million through a public offering. The offering fails to raise the anticipated funds with proceeds of only $3.8 Million.
November 2011	Azure intensifies effort to find Chinese partners willing to invest in Azure Dynamics. Meetings with a few Chinese firms are held, resulting in follow-up visits scheduled for March 2012.
December 2011	November financing fails. Azure reduces headcount by 15%, eliminates staff RRSP and 401K contribution benefits and reduces travel & discretionary expenses.
January 2012	Azure sales for Q4 2011 fall severely short of forecasted demand for Transit Connect Electric (410 units) and Balance Hybrid (59 units). Actual Q4 sales are 176 units and 56 units, respectively.
January 2012	Azure hires Lazard Frères & Co to conduct a Sales or Investment Solicitation Process. No offers to purchase Azure materialize. Azure management believes they will run out of cash before it can conclude negotiations to sell the business.
February 2012	Azure files a preliminary short form prospectus hoping to close in mid-March 2012. Proceeds from the offering are expected to be $10.5 million. Azure hope this will buy enough time to conclude negotiations with potential buyers through the SISP process started in January.
March 2012	The Ontario Securities Commission (OSC) informs Azure that it will not accept the February prospectus because of concerns with the degree of dilution for current shareholders. With this refusal by the OSC, Azure has no ability to raise capital, and since Azure is unable to meet its cash obligations as they come due, it is technically insolvent.
March 2012	On March 26th, 2012, Azure Dynamics files for bankruptcy protection in the Supreme Court of British Columbia under the Companies' Creditors Arrangement Act ("CCAA"). Azure also files a petition under Chapter 15 of title 11 of the US Bankruptcy Code to seek recognition and enforcement of the foreign CCAA proceedings in the US. The court approves the petition of Azure to seek protection.
March 2012	On the basis of the approval of the CCAA filing for bankruptcy protection, Azure announces a layoff of 120 of the existing 161 employees including all staff in Boston, Detroit, the UK, and 50% of the Vancouver staff. The Boston, Detroit and UK facilities are all closed. A group of approximately 25 of the Vancouver employees and two Detroit executive officers are all that remains of the Azure staff.
April 2012	Azure enters the restructuring process. Ernst & Young are appointed Monitor of the restructuring process by BC Supreme Court. Azure obtains 2 months of interim Debtor In Place ("DIP") financing.
April 2012	Azure continues discussions with potential suitors as part of the Sales or Investment Solicitation Process (SISP). Approximately six firms engage in due diligence of the Azure Dynamics business, and are allowed to inspect Azure's records using an online virtual due diligence data room.

Azure's most recent efforts to close an equity financing failed because of the refusal by the Ontario Securities Commission to issue a receipt for a final prospectus. Without this financing, and without immediately available alternatives, Azure Dynamics became insolvent (unable to meet its debt obligations as they became due). On March 26th, 2012, Azure sought bankruptcy protection under the Canadian Companies' Creditors Arrangement Act (CCAA) in the Province of British Columbia's Supreme Court. The court accepted the motion, and Azure is currently involved in a restructuring process with short term financing while it pursues strategic options for sale of the firm as a going concern rather than a liquidation of assets (referred to as a Sale and Investor Solicitation Process or SISP). The SISP proposal to the court outlines a proposed solicitation process, cash flow forecasts for interim financing, and the conduct of a subsequent auction in the event of competing bids.

1.2 Project Objectives

The objectives of this project are:

1. To perform a strategic analysis of Azure's positioning in the marketplace and provide recommendations (based on what knowledge was available either pre-insolvency or post-insolvency) to improve competitiveness and to support future growth of business in light of increasing competition in current space.
2. To analyze the NPD product opportunities from the perspective of the fleet truck customer (specifically looking at return on investment, actual needs, tax incentives, etc.) as well as from Azure perspective (opportunity cost, availability of technology, ability to deliver, size of market, customer needs, etc.). Assess if these opportunities are a good strategic fit and is consistent with the overall market positioning of objective 1.
3. To identify strategic options that will confront Azure's financial weaknesses. Specifically, these strategic alternatives must address cash flow difficulties, resolve the product cost structure and gross margin issue, and put Azure on a stable foundation where it is able to invest in new product initiatives to capture the market opportunities.

1.3 Structure of the Report

Chapter 2 ""Commercial Hybrid and Electric Vehicle Markets: Opportunities and Market Drivers" provides an in-depth analysis of commercial trucking markets in North America and Europe where Azure sells hybrid-electric vehicle (HEV) and battery-electric vehicle (BEV) powertrain systems and products. This chapter starts with an overview of the economic, technological and regulatory drivers and restraints governing adoption of HEV and BEV technology and the electrification of commercial fleets. The analysis covers the market structure and segmentation of the commercial truck industry. To provide further insight into the purchasing decision process, the chapter considers the value proposition for fleet customers within each of several selected segments using models for both the Total Cost of Ownership (TCO) and Payback Period. The chapter examines the adoption timeline and provides various scenarios for hybrid electric and electric vehicle market penetration. Finally, the chapter presents a generic industry supply-chain model for HEV, PHEV and BEV commercial vehicles.

Chapter 3 provides an assessment of the "Attractiveness of the Commercial Electric Vehicle Industry" from a variety of standpoints. The chapter first considers the market attractiveness by examining the competitive landscape for both light-duty commercial vehicles (LCV) and medium-duty commercial vehicles (MCV) where Azure Dynamics participates. Sample profiles of competitors in these segments are provided. The chapter provides a comprehensive Porter 5-Forces analysis of commercial truck markets to identify threats to incumbent industry participants. The chapter finally provides a summary of the key success factors for Azure's participation in these market segments.

Chapter 4 "Value Chain and Core Competency Analysis of Azure Dynamics" uses a value chain analysis approach to observe the flow of goods within Azure Dynamics including the primary and secondary activities necessary to support this flow. The enquiry identifies those stages within the chain where value is added and the nature of Azure's competitive advantage. The firm's resources and organizational core capabilities are evaluated using a VRIO (Value, Rarity, Inimitable, exploited by Organization) framework, and are mapped to strategic assets.

Chapter 5 "Financial Performance" continues the internal analysis of Azure by providing a detailed financial review of Azure Dynamics' performance including a five-year financial history of the firm, and an examination of factors leading to the recent insolvency of Azure. The chapter also looks at efforts to restructure the firm during the bankruptcy protection proceedings.

Chapter 6 "Strategic Fit Assessment for Azure Dynamics" determines the degree of fit between Azure's generic strategy of Differentiation Focus and the business model, organizational capabilities, core competence, and key success factors for the target markets.

Chapter 7 "Analysis of Strategic Alternatives" develops a series of strategic options and evaluates these under various scenarios. A set of criteria is described using balanced scorecard (BSC) metrics to evaluate the strategic options from the perspective of finance outcomes, the value to the customer, the growth of the internal business, and the development of innovation and learning within the organization. The strategic options are laid out in detail, and a weighted score assessment is done using the BSC criteria.

Finally, Chapter 8 "Recommendations and Conclusions" answers the strategic questions in Chapter 1. The recommendations try to avoid a hindsight bias: the tendency to see the insolvency events that have already occurred in the past as being more obvious and predictable now than they were at the time in early 2011. The recommendation outlines both the preferred strategic option as of a pre-insolvency date in January 2011 assuming only knowledge that was available at that time, and the preferred strategic option post-insolvency in mid-2012 assuming knowledge that has become available more recently.

EXTERNAL ANALYSIS

2 Commercial Hybrid and Electric Vehicle Markets: Opportunities and Market Drivers

This chapter provides a macro-economic analysis of trends influencing the market for electric vehicles, an overview of technology alternatives, and an analysis of the market drivers behind adoption of "green" commercial truck fleets. In addition, the value proposition for fleet owners is examined, along with the supply chain for the commercial electric vehicle industry.

2.1 Macro-Economic Drivers for Vehicle Electrification

There has been much apprehension in the last decade concerning the peaking of world oil production from depleted oil reserves, and rising concern over the severe environmental impact of vehicle emissions on our climate. These factors have prompted the reconsideration of electricity as an alternative fuel for both passenger vehicles and commercial fleets in the transportation sector of the US and Canadian economies. The continuing interest in the electrification of the automotive industry is being driven by a desire to mitigate the consequences of US oil dependency and the need to reduce greenhouse gas emissions for environmental sustainability (Indiana University School of Public and Environmental Affairs, 2011).

2.1.1 Energy Security Consequences of Oil Dependency

The first major factor driving electrification is the concern over energy security here in North America due to our dependence on a steady supply of oil to fuel our economy. According to the US EIA's Annual Energy Outlook 2010, the US uses more than one quarter of the global petroleum production (U.S. Energy Information Administration, 2010a). The transportation sector is solely responsible for more than 70% of the US oil usage, primarily from consumption by passenger vehicles and light-duty trucks.

The economy is strongly affected by this excessive dependence on oil. Data from the US Department of Energy demonstrates that there is strong correlation between spikes in the price of crude oil and economic recessions. In the past 30 years in the US, there have been at least 5 major peaks or spikes in oil prices (1973-74, 1979-80, 1990-91, 1999-2000, and 2008-2009) and in each case (Figure 7) the price escalation was followed by an economic downturn (Davis, Diegel, & Boundy, 2010). Part of the economic problem is related to the volatility of oil prices during times of political instability and the relatively small amount of spare capacity. The US imports in excess of 55% of its oil consumption from countries such as Saudi Arabia, Iraq, Russia and Venezuela, none of whom are predisposed to maintaining an uninterrupted supply of oil solely to serve US interests relative to those of other customers (Kassatly, 2010). Prices of light crude oil have escalated to $125 a barrel in April 2011 due in part to concerns over the recent civil unrest in Libya and Egypt, the huge Deepwater Horizon oil spill in the Gulf of Mexico, and the recent nuclear accident in Fukushima Japan earthquake.

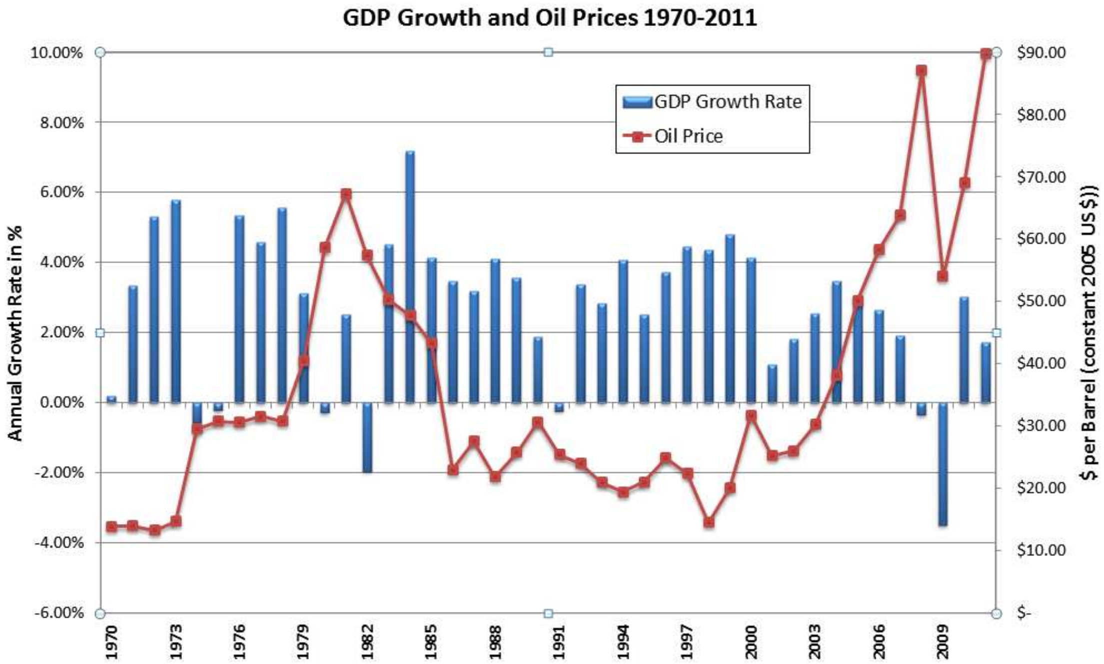


Figure 7 – GDP Growth and Oil Prices, 1970-2009
Data Source: US Transportation Energy Data Book: Edition 31 (Davis, Diegel, & Boundy, 2011)

The oil supply situation is only going to become worse in future as the automobile markets in the Asia Pacific region come online. The majority of the world population in Asia Pacific region and non-OECD countries is still without cars, but this is changing quickly. A study predicted that the number of vehicles in operation (VIO) in the world will increase from 0.7 billion in 2000 to 2.5 billion by 2050 (Chan, 2002). The automobile markets with the fastest growth are in China and India where they are experiencing 7 to 8% annual growth compared to 2% growth in the United States and Europe (Davis et al., 2010). China is already the second-largest auto market and will likely surpass the United States as the world's largest by 2030 when approximately 30% of the global vehicle fleet will be located in China (Gao et al. 2008). Although additional petroleum supplies from on-going exploration activity and advances in extraction methods (e.g. shale oil, tar sands) will somewhat mitigate the depletion of reserves, increased oil prices over the next 20 years are inevitable. The US Energy Information Agency has provided a projection of world oil prices to 2035 (see Figure 8).

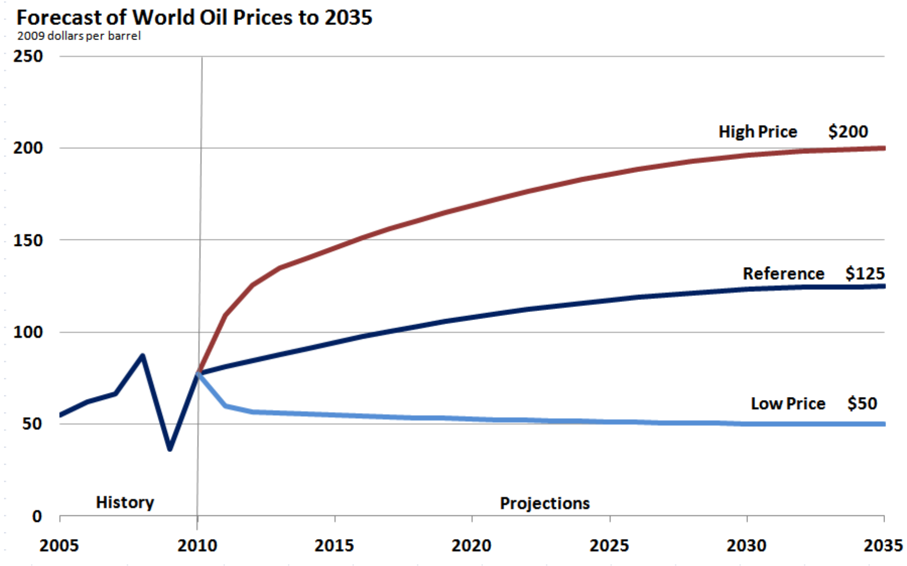


Figure 8- Forecast of World Oil Prices to 2035
Data Source: (US EIA, Annual Energy Outlook 2011, www.eia.gov/oiaf/aeo)

2.1.2 Reduced Emissions for Environmental Sustainability

The second major driver of interest in the electrification of transportation fleets is caused by the impact of the petroleum-based transportation system on the environment.

Global climate change is manifesting itself with effects such as rises in the sea level, increases in global ocean and air temperatures, the melting of polar ice caps, the loss of animal habitat, and extreme weather volatility leading to more frequent drought, forest fires, and hurricanes. It has grave implications for the loss of agricultural production and changes in human settlement.

A recent report stated that there is a strong linkage between greenhouse gas (GHG) emissions and the recent observations of global warming.

> "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. The observed widespread warming of the atmosphere and ocean, together with ice mass loss, support the conclusion that it is extremely unlikely that global climate change of the past 50 years can be explained without external forcing and it is very likely that it is not due to known natural causes alone." (Intergovernmental Panel on Climate Change, 2007)

The world energy demand is forecast to rise almost 50% by 2035, and this growth in demand will be met primarily by the combustion of fossil fuels. According to the International Energy Outlook 2010 report (U.S. Energy Information Administration, 2010b), world CO_2 emissions are predicted to grow 43% from 2007 to 2035, resulting in a 3 °C increase in average global temperatures (see Figure 9). In the US, GHG emissions from transportation are expected to increase by 80% by 2030 (Electric Power Research Institute, 2007).

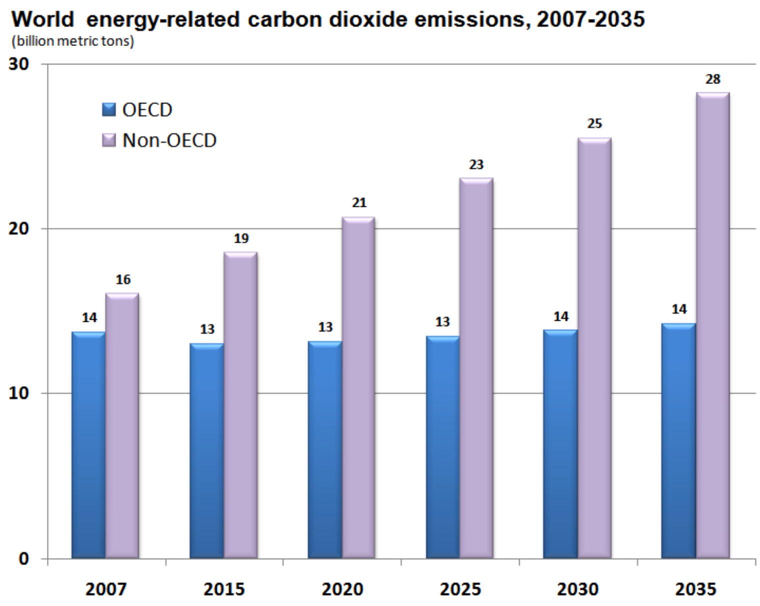


Figure 9 - World Energy-Related CO2 Emissions 2007-2035
Data Source: (U.S. Energy Information Administration, 2010b)

2.2 Enabling Technology – Alternative Vehicle Powertrain Options

If we continue to be dependent on internal combustion engines (ICEs), then where will all the oil come from? How will we reduce the sheer volume of CO2 and NOx emissions? Increasing the supply of fuel is a dubious option and is not the key to solving this dilemma over the long term. Decreasing the demand for fossil fuels involves a major shift away from the conventional internal combustion engine (ICE) towards one of the following alternative vehicle powertrain options:

- **Series Hybrid Electric Vehicle (HEV)** – Torque to the wheels of the vehicle comes from an electric motor. Power is delivered to the motor either from a battery pack or from a gasoline-powered generator.
- **Parallel Hybrid Electric Vehicle (HEV)** – In a parallel hybrid, both the electric motor and an internal combustion engine jointly generate the traction power that drives the wheels with some sort of dual power-split transmission. This powertrain subsystem connects to a transaxle or differential gearbox.
- **Hybrid Hydraulic Vehicle (HHV)** – Instead of electric power, a hydraulic hybrid vehicle powertrain uses pressurized fluid as an alternative power source to the engine.
- **Plug-In Hybrid Electric Vehicle (PHEV)** – The PHEV is similar to a traditional hybrid-electric vehicle but a PHEV adds the ability to plug the vehicle into a standalone charging pedestal.
- **Battery Electric Vehicle (BEV)** – A BEV is also referred to as an "all-electric vehicle" or "full electric vehicle". A battery pack (typically lithium-ion variety) supplies electric power to an AC induction motor, which is controlled by a high-power inverter. The motor is connected to a single-speed transmission delivering torque to the vehicle. BEVs are also charged by plugging the vehicle into a charging pedestal.

For a more in-depth discussion, the reader is directed to Appendix B, which provides a background to ICE, HEV, PHEV, BEV and HHV vehicles. For this thesis, a reference to the generic term electric vehicle (EV) can mean either a plug-in hybrid PHEV or a full battery-electric BEV (also referred to as an "all-electric" vehicle); both of these vehicle types use external plug-in power sources. By contrast, hybrid electric vehicles (HEVs) are still entirely dependent on fossil fuel sources despite lower fuel consumption.

The major benefit of vehicle electrification is reduced oil consumption, leading to a corresponding reduction of water contamination from oil drilling, a reduction of the number of oil spills (e.g. the recent British Petroleum Deepwater Horizon spill), and a reduction of smog and soot in the air. Electrification can also make a major contribution to the reduction of greenhouse gas (GHG) emissions as follows (MIT Energy Initiative Symposium, 2010):

- Conventional Hybrids (HEVs) reduce CO_2 emissions by 33% compared to ICEs.
- PHEVs powered by coal-generated electricity which is so prevalent in the US, have lower CO_2 emissions than those from an ICE but higher CO_2 emissions than conventional hybrids according to well-to-wheels analyses (Electric Power Research Institute, 2007). Figure 10 shows the emissions profiles of PHEVs using various generation technologies
- Plug-in Hybrids (PHEV) CO_2 emissions can be even further decreased by up to 66% compared to ICEs by integrating cleaner carbon-free forms of electricity feedstocks including hydro-electric, nuclear, biomass, solar, wind, geothermal, tidal or other renewable power sources. PHEV emissions can also be reduced by retrofitting existing coal plants, and implementing carbon capture and sequestration measures.

The emissions profile of EVs (with significant market penetration) will improve as the electricity sector becomes less dependent on carbon-based feedstocks.

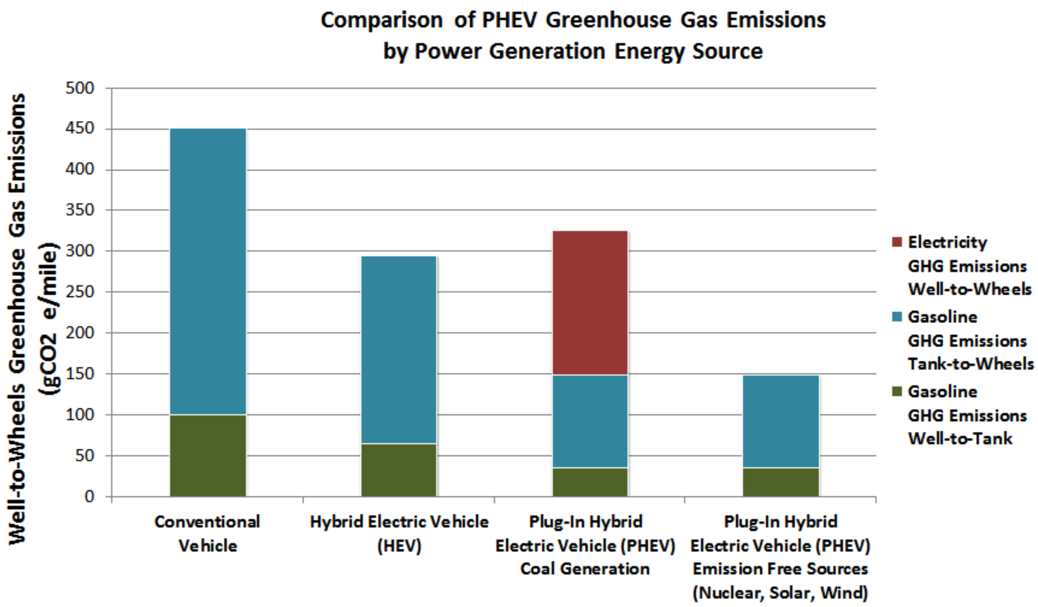


Figure 10 - Comparison of PHEV Greenhouse Gas Emissions by Electric Power Source
Data Source: (Electric Power Research Institute, 2007)

2.3 Commercial Vehicles Expected To Lead Electrification

The previous section identified the enabling technologies for electrification such as ICE, HEV, PHEV and full BEV vehicles. However, initial vehicle costs of electrification can be quite high depending on the component costs, and these incremental cost premiums relative to the incumbent ICE technology are serious impediment to the adoption of alternative powertrain technologies in certain automotive industry segments.

Consumers in the passenger car segment are less likely to be early adopters of EV technology when compared to fleet operators in the commercial vehicle market. A consumer is typically more sensitive to the high initial sticker price of hybrid vehicles, plug-in PHEVs and full battery BEV vehicles. They will often purchase a vehicle for a variety of reasons other than cost, including aesthetics and style.

For example, in a US Department of Energy study, the incremental costs for various powertrain technologies were compared for passenger cars (Cleary et al, 2010a). In 2010, a reference mid-size car with ICE powertrain had the least expensive initial cost of $21,390 ($22,566 with State Sales Tax). HEV and PHEV-30 cars have an additional price premium of approximately $4460 and $22900 respectively relative to ICE passenger vehicles. See Figure 11.

Breakdown of projected 2010 purchase prices for each vehicle type			
Base Vehicle Assumption - MSRP = $21,390			
Component Costs	**ICE**	**HEV**	**PHEV-30**
Powertrain			
Engine	$3,708.81	$2,191.09	$2,191.09
Transmission	$2,398.69	$2,289.66	$2,289.66
Motor/Inverter	-	$3,933.85	$3,933.85
Energy Storage	-	$1,918.95	$24,423.00
Recharging Plug and Charger	-	-	$662.91
Other			
Glider	$15,282.51	$15,282.51	$15,282.51
220V Dedicated Circuit Installation	-	-	$1,000.00
State Sales Tax	$1,176.45	$1,408.88	$2,695.85
Total Initial Purchase Cost	$22,566.46	$27,024.94	$52,478.87
Incremental Cost for HEV or PHEV-30	-	$4,458.48	$29,912.41

Figure 11 - Incremental Purchase Prices for HEV and PHEV-30 vehicles – Source: (Cleary et al, 2010b)

Even with cuts in reduced battery and component costs by 2030, HEVs and PHEV-30s passenger vehicles are still expected to command a price premium of approximately $1,050 and $5,535 respectively relative to ICEs cars. See Figure 12 for a graphical comparison of estimated purchase cost for each vehicle type both today and in 2030.

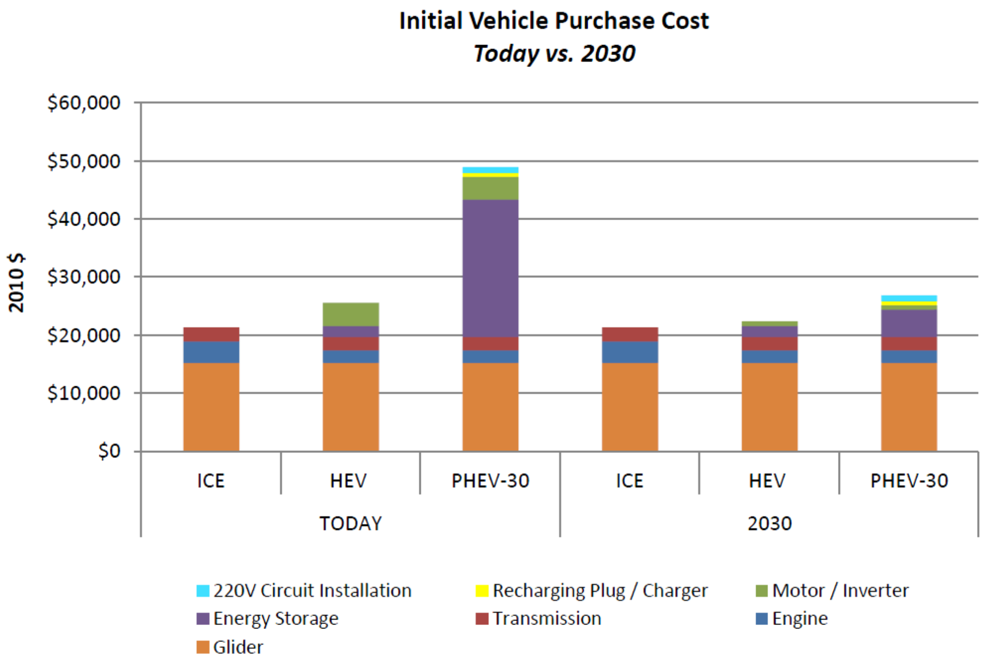


Figure 12 - Initial Cost Comparison for ICE, HEV and PHEV Cars in 2010 & 2030
Data Source: (Cleary et al, 2010a)

Incremental costs for commercial HEV, PHEV and BEV vehicles are also substantial. However, the vehicle acquisition process for commercial fleet customers is more likely to be guided by economic factors such as the Total Cost of Ownership (TCO) of a vehicle (rather than the initial capital outlay). A fleet customer typically amortizes upfront CapEx costs over the lifetime of a vehicle using leasing or similar arrangements. If electric drive technologies meet the mission needs of a given fleet and can reliably demonstrate a return on investment compared to an internal combustion engine vehicle, fleet operators with an eye on the bottom line should be willing to invest in efficiency.

The operational profile of commercial fleet operators is better suited to HEV and EV technology than the profile for passenger car fleet operators. For example, in dense urban settings, a typical commercial delivery van will travel a fixed route of less than 100 miles per day. In these urban areas, traffic congestion dictates that there will be lots of starts and stops with significant idle time, and there will also be multiple drops or collections. Many commercial delivery vehicles return to the same depot base at the end of every day which conveniently allows for centralized charging.

Finally, by serving as a first market for electric drive technologies, fleet operators could generate a number of spillover benefits for the broader consumer market. Substantial volume commitments of sales to large commercial and government fleet customers will help to drive the development of scale efficiencies and cost reductions in lithium-ion batteries and other powertrain components. Fleet adoption of PHEVs and BEVs could also help to overcome the lack of charging infrastructure which is also constraining development of the passenger market.

2.4 Market Drivers for Adoption of "Green" Commercial Truck Fleets

There are several key factors driving the adoption of alternative HEV, HHV, PHEV, and BEV powertrain technologies for "green" commercial trucks. Certain technologies benefit more from these drivers than others.

A variety of benefits accrues to fleet customers depending on the type of powertrain technology used in a commercial vehicle. Some of these benefits are direct (e.g. lower initial capital costs or lower operating costs) while others are indirect (lower emissions or extended vehicle range or reliability in adverse operating conditions).

These factors include:

- **Total Cost of Ownership (TCO)** – Fleet operators will most often adopt vehicles based on the fully-burdened cost of purchasing, refueling, and maintaining a vehicle over the entire ownership period. There is a strong incentive to offset high initial costs for HEV or EV technology in trucks using operational cost savings. A recent survey from Frost & Sullivan of the US Light Duty Truck market asked 80 fleet managers to identify the most significant factors affecting adoption of light-duty trucks (Kar & Randall, 2010). The results in Figure 13 indicate that the Total Cost of Ownership (TCO) is by far the most important contributing factor to the decision to purchase a vehicle by a fleet manager (based on percentage of respondents).

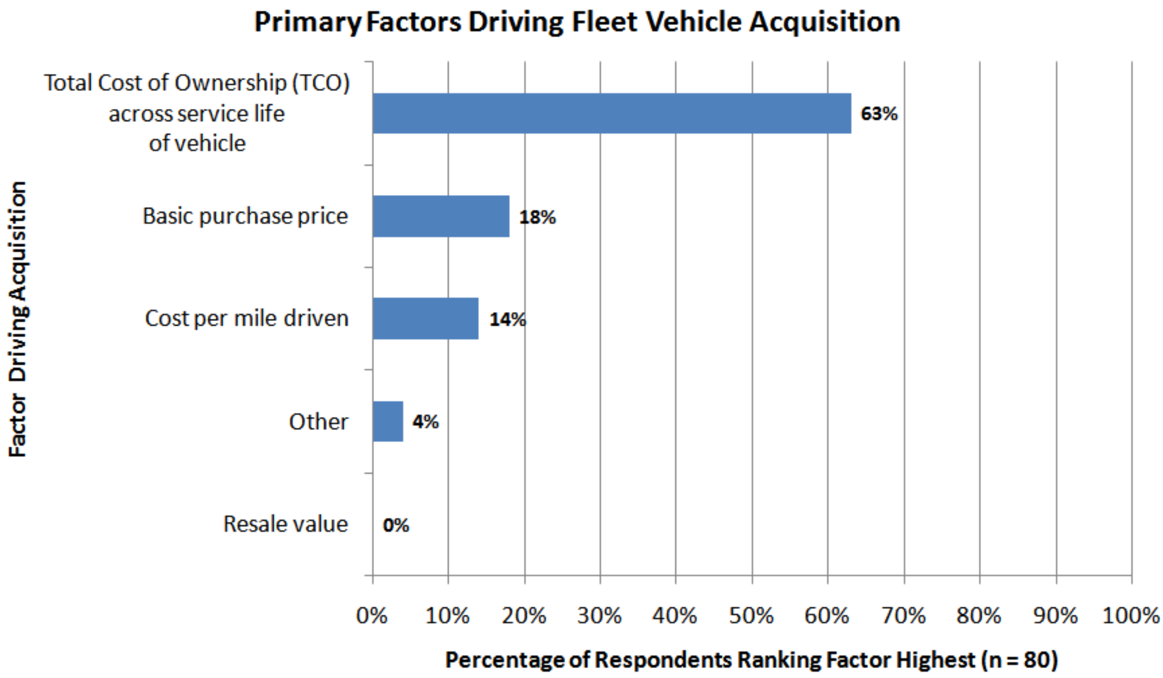


Figure 13 - Fleet Owners Ranking of Primary Factors Driving Vehicle Acquisition – Data Source: (Kar & Randall, 2010)

- **Fuel/Electricity Cost Savings** – Savings based on the relatively low cost of electricity compared to the high cost of gasoline are a primary driver of the benefits of PHEV and EV trucks. Although there are fuel savings for hybrids, they are not as substantial as those for a PHEV or all-electric BEV. According to Frost & Sullivan, 59% of fleet owners rated fuel efficiency as the number one benefit (Kar & Randall, 2010). See Figure 14.

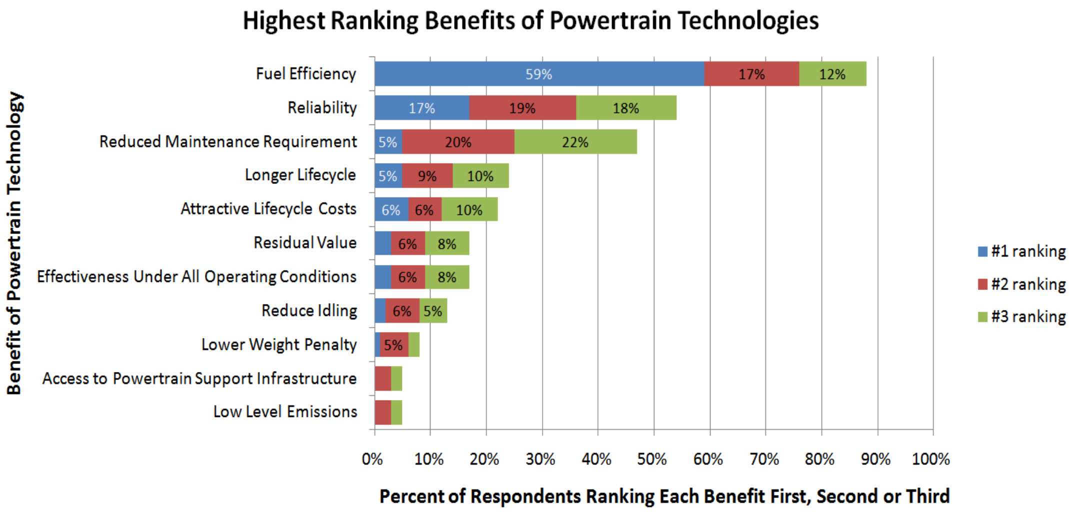


Figure 14 - Highest Ranking Benefits of Powertrain Technologies, Data Source: (Kar & Randall, 2010).

- **High Vehicle Utilization (Duty Cycle)** - A vehicle with a high utilization rate (or duty cycle) based on the daily or annual miles travelled will enable a faster payback of incremental costs for HEV or EV trucks.
- **Route Predictability and Driving Cycle Suitability** – The route predictability (driving cycle) and hence the necessary range for a commercial vehicle is a driving factor for adoption of a pure BEV truck (lower range anxiety). This is not a factor for hybrid technologies where vehicle range is extended with an internal combustion engine (ICE).
- **High Level of Central Fleet Depot Usage** – Adoption of plug-in PHEV or BEV powertrains is increased in some fleet segments (e.g. parcel delivery trucks, but not line-haul trucks) where there is a high level of central fleet depot usage. This makes it easy to provide charging infrastructure. This is also not a factor for the conventional hybrid (HEV, HHV).
- **Lower Maintenance and Servicing Costs** – Fleet vehicles with traditional ICEs require regular service for fluid changes (oil, transmission and brake fluid) as well as costs for repair and replacement of items such as brake, transmission and engine components. Electric drive systems on the other hand, have lower maintenance and repair costs (due to fewer moving parts and less wear). In Figure 14, reliability and reduced maintenance rank as the second and third highest benefits (with 17% and 5% respectively) (Kar & Randall, 2010).
- **Improved Corporate Sustainability Profile** – A shift away from petroleum-powered vehicles towards the adoption of more efficient "green" vehicle technologies such as hybrids (HEVs and HHVs), and plug-in electric vehicles (PHEVs and BEVs) not only offers lower TCO costs, but demonstrate a fleet operator's commitment to sustainable business practices.
- **Regulations, Subsidies and Incentives for Electrification –** Demand for commercial xEV trucks can be stimulated by offsetting the higher initial purchase price with tax credits or rebates which can make xEV trucks as inexpensive as a comparable ICE or gasoline-powered truck. In theory, the lower operating costs will tip the balance for the fleet buyer in favour of deciding to buy xEV vehicles. Government subsidies should spur demand for these vehicles until manufacturers can achieve greater economies of scale and cost efficiencies to reduce component costs.

2.5 Market Challenges for Adoption of "Green" Commercial Truck Fleets

There are also key market restraints that are potential barriers to adoption of HEV, HHV, PHEV, and BEV technologies for truck fleets. Barriers to adoption include:

- **Vehicle Costs** – Truck makers face a major issue with the high cost of hybrid and electric vehicle components. Although commercial fleets owners have shown interest in electrifying their fleets, they have been unwilling so far to purchase large quantities of hybrid-electric and plug-in electric vehicles (Lowe, Ayee, & Gereffi, 2009). Despite cheaper operating costs, the high up-front capital costs remain as a major impediment to growth. Without sufficient sales volumes to drive down costs, commercial xEV makers will need to keep prices high enough to recover production costs. Governments can step in to resolve this chicken-and-egg impasse by jump-starting the market with xEV subsidies. According to a study by Calstart (an industry consortium of vehicle technology firms), annual fleet orders for hybrid electric trucks are about 500 to 1000 vehicles. Calstart has suggested that annual truck sales will need to reach at least 3000 to 5000 before costs can be driven down to a level which is low-enough to sustain market demand (Van Amburg, 2009).

- **Technology Barriers** - There are major challenges for manufacturers of HEV and EV trucks in the area of weight reduction and improving aerodynamic efficiency. HEV and EV trucks have a large overhead of non-cargo related weight (particularly batteries) which reduces available cargo capacity and increases the amount of power needed at vehicle startup. A vehicle with an electric powertrain needs to be as light as possible to minimize this overhead (Lowe et al., 2009). Truck body aerodynamic efficiency also needs to be improved to reduce fuel consumption.

- **Capital Expenditures vs. Operating Expenditures -** There is typically intense competition for capital within a given company or institution. Despite Total Cost of Ownership (TCO) advantages for HEV or EV trucks, high capital cost requirements will still prove challenging for many fleet operators (Fairley, 2011). Large fleet operators are unwilling to tie up capital to support substantial volumes of hybrid and electric drive vehicles. A typical fleet operator will selectively consider the adoption of hybrid or EV trucks for niche applications such as urban delivery where the operational requirements (high utilization, short radius of operation, large number of stops and starts) are best suited to the technology. Some manufacturers – most notably Renault – have tried to adapt by breaking out electric batteries as a separate lease item to make EVs affordable.

- **Charging Infrastructure Costs** - Even for fleets that centrally park, the cost of installing charging infrastructure may be significant. With Level II EVSE charger costs averaging $2000 per unit, the cost of installing enough chargers to support a fleet of several dozen EVs or PHEVs could be challenging. Level III charging may offer faster charge times and reduced unit requirements, but costs are still too high.

- **Supply Chain Insufficiencies** – Achieving ample production of affordable Li-Ion batteries may be the single greatest challenge to large-scale commercialization of plug-in EVs. Batteries must reach a reasonable price in order for EVs to be competitive with conventional vehicles and hybrid electric vehicles (HEV) in forthcoming decades. In order to produce batteries that meet the required standards of durability, quality, and safety at a reasonable cost, many issues of the battery industry must be addressed. These issues include (but are not limited to) technology maturation, increased domestic production, raw material availability, and market readiness.(Cleary, Sikes, & Lin, 2010)

- **Fuel Prices** - The price of gasoline or diesel fuel will have an impact on HEV, PHEV and BEV truck market penetration. As gasoline prices rise, fleet operators will opt for more fuel-efficient trucks to cut down on operating costs. For every $0.50 increase in the price per gallon of fuel, the payback period for a HEV truck will decrease by 6 months. Likewise, as fuel prices drop, the payback period to recover the incremental cost of HEV, PHEV or BEV powertrains will increase proportionately.

- **EV Range** – A fleet operator may have a perception (even if unfounded) about the ability of an electric truck to meet the operational needs of the fleet with respect to vehicle range. This issue is sometimes referred to as “range anxiety”. It only affects the adoption of range-limited BEV trucks or vans that run entirely on battery power. Range anxiety is not a barrier to the adoption of hybrid HEV and PHEV trucks. The best approach to mitigate range anxiety is to make sure that a fleet driver has much information as possible on the state of charge, or the location of a recharging station.

- **Charge Time** – On one hand, a fleet operator needs to have a high vehicle utilization to make PHEV or EV technology affordable - perhaps more than 100 miles per day over two shifts. However, the operator needs to find gaps during the day to recharge the battery pack of the vehicle. The amount of time it takes to recharge a battery pack may vary anywhere from 12 hours for Level 1 (120V AC Charging), to 6-8 hours for Level 2 (240V AC charging), or to as little as 30 to 60 minutes for Level 3 (High Voltage DC fast charging). Thus, it is imperative that fleet operators have access at least to a Level 2 charging station, and preferably to a Level 3 fast charging station to enable them to reach a sufficiently high level of vehicle utilization.

2.6 Commercial Truck Market Segmentation

Industrial markets can be segmented in several ways in order to assess segment attractiveness and to determine which segment to target. Appendix A contains more information on the nested segmenting approach adopted here (Bonoma & Shapiro, 1983). At the macro level, the target market under consideration for this analysis is the commercial truck market. However, the commercial truck market can be segmented into groups of fleet owners and operators with similar needs. These owners are more likely to be concerned about vehicle characteristics such as total cost of ownership and resale potential. Each fleet is different, and there are a number of dimensions with which to segment fleets including the following:

- **Duty Class of vehicle** – GVW classes - light- to heavy-duty trucks, and buses
- **Application** – classification by vocation or purpose of vehicle e.g. parcel delivery, postal
- **Vehicle Utilization** – classification by daily or annual vehicle miles travelled (VMT)
- **Geographic Region** – North America, Europe, or Other regions
- **Fleet Size** – classified from small fleets (< 10 vehicles) to large fleets (1000+ vehicles)
- **Sector** – Large Government or Private Fleets, or Small / Medium-Sized Enterprises (SMEs)

Individual sub-segments can be defined using nested combinations of any of these attribute classifications. Each of the attribute dimensions is described in further detail below.

2.6.1 Segmentation by Duty Class of Vehicle

Commercial truck fleets include vehicle size and weight classifications from light-duty commercial vehicles (LCV), medium-duty commercial vehicles (MCV), heavy-duty commercial vehicles (HCV), and buses. See Table 3 for a breakdown of commercial vehicle classifications by weight for North America and Europe.

Table 3 - Commercial Vehicle Classification in North America and Europe

Vehicle Class	Types of Vehicle	Application or Vocation Examples	North America (US DOT class)	Europe (ACEA class)	Example
Light-duty Commercial Vehicles (LCV)		• Urban / city Delivery and Pickup • Utilities • Airport operations • Facilities management • Catering • Tradesman / Contractor • Postal	Class 1-3 trucks (GVW < 14000lbs)	GVW < 3.5t tonnes (< 7700 lbs.)	Azure Dynamics / Ford Transit Connect Electric Van Iveco Daily Hybrid Van Morgan Olsen LLV Postal Van
Medium-duty Commercial Vehicles (MCV)		• Home delivery • Logistics • Parcel Delivery • Utilities Boom /Bucket Truck • Airport operations • Medium shuttle buses	Class 4-5 trucks (GVW 14001 to 19500 lbs.)	GVW from 3.5t to 16t (7700 to 35300 lbs.)	Hino 155h Diesel Hybrid Electric Truck Azure Dynamics Hybrid Electric City Delivery Van Azure Dynamics Balance Hybrid Delivery Van Altec Hybrid Electric Bucket Truck
Heavy-duty Commercial Vehicles (HCV)		• Beverage • Waste and Recycle collection • Mining • Construction dump trucks • Cement trucks • Day-cab freight • Refrigeration • Line haul freight trucks (sleeper cabs) • Furniture • Moving / Storage	Class 6-8 (GVW > 19500 lbs.)	GVW > 16t (GVW > 35000 lbs.)	Freightliner Beverage Truck Peterbilt Model 320 Hydraulic Hybrid Refuse Truck McNeilus Ngen Compressed Natural Gas (CNG) Cement Mixer Truck Peterbilt Model 386 HLA Hybrid Line Haul Class 8 Sleeper Cab Truck
Buses		• City Transit Buses • Inter-city Motor Coaches • School Buses			New Flyer Xcelsior Inter-city Coach NABI (North American Bus Industries) C-45 low-floor urban transit bus as used by Los Angeles Metro Rapid fleet

2.6.2 Segmentation by Application

Understanding the application for a fleet vehicle is critical to choosing the best vehicle powertrain technology. The intended application is the key determinant for vehicle utilization, radius of operation and range. It also has a major bearing on the typical driving cycle including the number of stops and starts. For instance, step vans that service a set route, such as a package delivery service, may find BEV operation an effective, low-polluting alternative. HEV hybrids are popular for beverage delivery because of frequent stops and starts. Vocational trucks such as refuse trucks, and utility bucket trucks often employ CNG, propane, or HEV and HHV hybrid powertrains. HEV trucks and trucks fuelled by CNG or propane are popular alternatives to gasoline ICE powertrains for school buses. Application class definitions and examples are shown in Table 4.

Table 4 – Vehicle Application Classification

Application	Definition	Example Application Types
City Delivery	Pickup and delivery service within cities and/or suburban areas.	Auto Carriers, Moving Vans, Refrigerated Trucks, Beverage Trucks, Municipal Trucks, Flatbed Trucks, Newspaper Delivery Vans, Tankers, Livestock Haulers, Parcel Pickup Walk in Step Vans, Postal Vans, Towing Wreckers.
Construction	Movement of material to and from a job site.	Asphalt Trucks, Flatbed Trucks, Tank Trucks, Block Trucks, Landscape Trucks, Utility / Telecom Bucket Truck, Concrete Trucks, Dump Trucks.
Fire Service	Vehicles used to transport people and equipment for extinguishing fires or ambulance service.	Aerial ladders, Pumpers, Tankers, Aerial platforms, Ambulance
Heavy Haul	Movement of heavy equipment or materials at legal maximums or special permit Loadings.	Equipment Hauling Trucks, Flatbed Trucks, Lowboy Trucks, Steel Hauling Trucks
Line Haul	Movement of different types of freight in high mileage operation (over 60,000 miles/year).	Auto Haulers, Refrigerated Freight Trucks, Bulk Haulers, Livestock Haulers, Moving Vans, Flatbed Trailers, Pipe Haulers, General Freight, Tankers, Grain Haulers.
Logging	Movement of logs, chips and pulp between logging sites and/or mill.	Chip Haulers, Straight Truck With Trailers, Log Haulers, Tractors with Pole Trailers
Mining	Movement of rock, ore, gravel and minerals between sites and delivery sites.	End Dump Trucks, Hopper Trailer Combinations mine Bottom Dump Trailers, Transfer Dump Trucks, Semi
Motorhome	Vehicles generally used for non-commercial transportation and as traveling domiciles for families.	Recreational Vehicles
Refuse	Vehicles used for residential refuse/recycle pickup.	Front/Rear/Side Loaders, Sewer/Septic/Vacuum Trucks, Roll Off, Liquid Waste Haulers, Scrap Trucks, Transfer Vehicles, Residential/Commercial Pickup Trucks, Street Sweepers.
Rescue	Specialized vehicles for rapid acceleration to crash sites away from hydrant hook-ups.	Airport Rescue Fire (ARF), Crash Fire Rescue (CRF), Rapid Intervention Vehicles (RIV), Emergency Service trucks.
School Bus	Transporting students to and from school and/or school related events.	Front Engine Commercial Chassis buses, Front Engine Integral Coaches, Rear Engine Integral Coaches.
Intercity Coach	Transporting people and light freight between cities and/or suburban areas.	Tour Coach, Cross Country Coach
Transit Coach	Transporting people in and around city or suburban areas.	Airport Shuttles, City Buses, Shuttle Buss, Trolley Buses

2.6.3 Segmentation by Vehicle Utilization

The rate of vehicle utilization is a measure of the number of miles travelled over a given period, usually expressed in terms of the number of miles per day or the annual Vehicle Miles Travelled (VMT). The rate of vehicle utilization is very useful as a segmentation attribute, because it is an important distinguishing feature of various fleet applications. For instance, a heavy-duty Class 6-8 delivery truck typically travels **in excess of 150 miles/day** (**Long-haul**) without returning to same central depot at the end of each day (low route predictability). It has a much different operational profile than a medium-duty Class 4 urban or city delivery van that travels from **60-100 miles/day** (**Medium-haul**) with a high degree of route predictability. It is different again from a light-duty Class 2 Government van that travels **less than 50 miles/day** (**Short-haul**). Figure 15 shows how vehicle utilization based on miles/day can be used in conjunction with the duty class of vehicle to identify segments of fleet customers with various operational profiles.

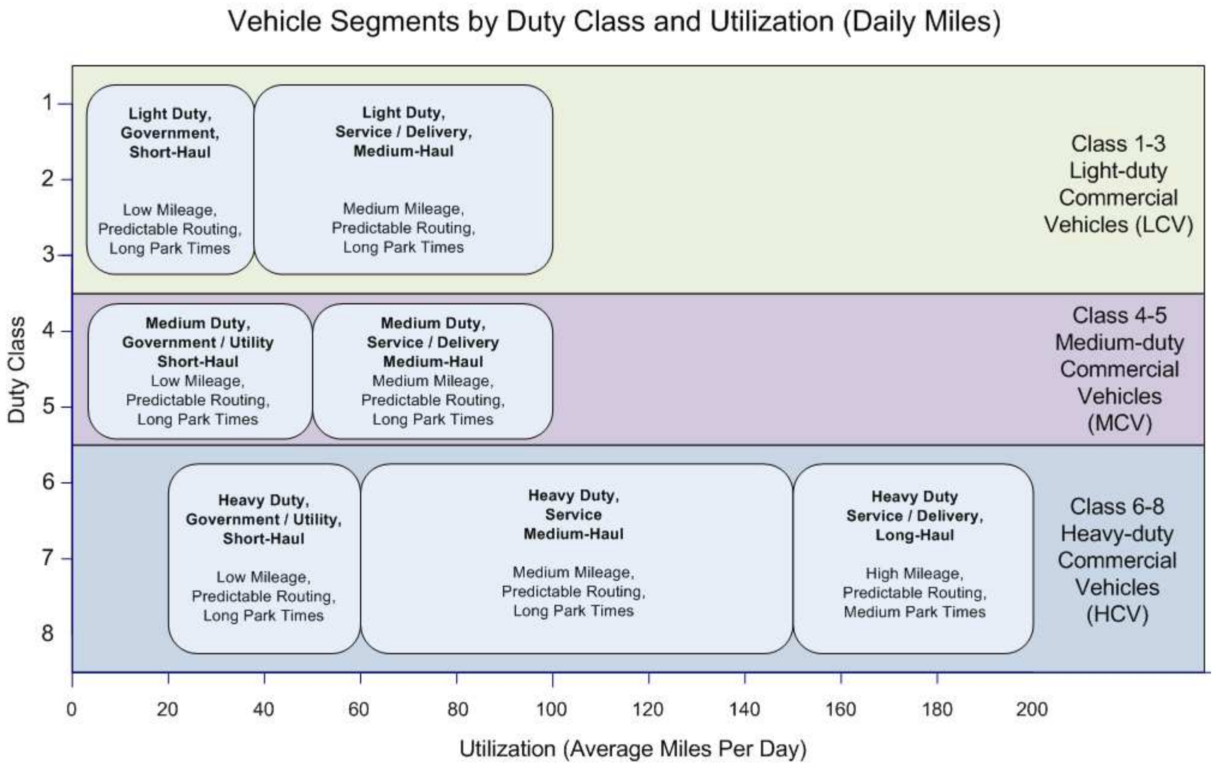


Figure 15 - Commercial Vehicle Segments by Duty Class and Utilization (Miles/Day), Source: Adapted from (Electrification Coalition, 2010)

A commercial HEV, PHEV or EV vehicle that exceeds a minimum daily mileage threshold (or an annual VMT amount) will provide a higher utilization, and therefore a proportionately higher level of fuel savings. This significantly reduces the time to payback the high up-front incremental capital costs (particularly battery costs) when compared to an ICE vehicle.

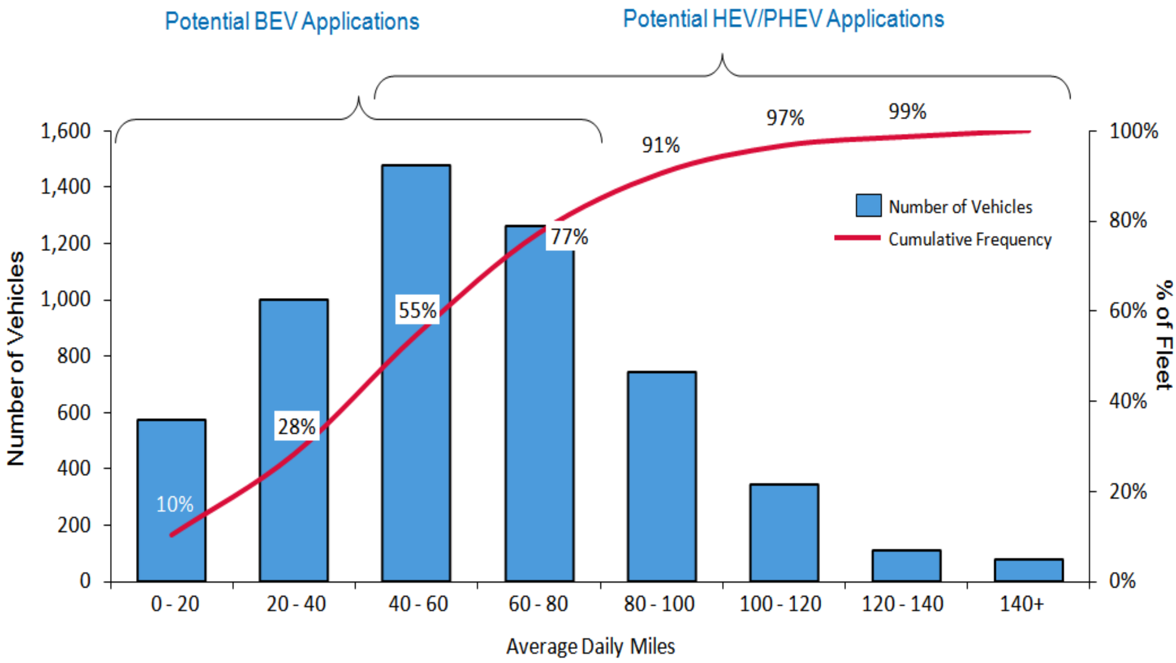


Figure 16 - Distribution of Light Duty Service Application Fleet Sizes by Average Daily Miles
Source: Adapted from annual fleet statistics at automotive-fleet.com

For pure BEV trucks, there is an upper bound to vehicle utilization based on the range available without a vehicle recharge. In Figure 16, at least 77% of the Class 1-3 LCVs used for Service applications travel less than 80 miles/day; these vehicles are well suited to BEV powertrains. However, consider a postal delivery application where a fleet operator desires to use a battery electric truck for 100 miles per day but the vehicle range on a single charge is limited to 70-80 miles. It may be possible for the postal operator to schedule two shifts per day with a gap between shifts for charging. Adoption of an EV for this type of application would be more likely if Level 3 DC fast-charging technology was used to minimize the recharge time between shifts. However, if Level 3 fast chargers were not available, then a fleet customer might be more likely to adopt a hybrid versus a plug-in electric vehicle.

2.6.4 Segmentation by Geographic Region

In the automotive industry, Europe and North America are unique geographic market segments that have formed primarily because of differences in fuel prices and truck size regulations. The considerable disparity in fuel prices between the two regions has resulted in a stronger customer demand in Europe for trucks with smaller and more fuel-efficient engines. Even within Europe, differences in fuel taxes and subsidies between countries have affected the demand for some powertrain types. For instance, in France and Germany, where excise taxes on ultra-low sulphur diesel fuel are lower than those on unleaded gasoline, there is higher market share of light-duty trucks with diesel engines.

Differences in vehicle regulations between North America and Europe have a profound impact on the popularity of certain types of vehicles. For instance, although tractor-trailer style cabs are more popular in North America for long-haul trucks, the Cab-over Engine (COE) configuration is more prevalent in Europe. North American laws and statutes limit the maximum length of tractor-trailer units to 75 feet. By contrast, there are tighter restrictions in Europe on the length of tractor-trailer rigs. Europe has narrower roads, tighter corners and limited access to urban areas from the highway. Thus, the COE body style has become the dominant design for most European long-haul fleets. The conventional cab configuration in North America provides more sleeper cab comfort, less engine noise for the driver, and greater power.

Europe and North America are likely to have differing adoption rates for electrified commercial vehicle technology. The relatively high preference by fleet customers in Europe for diesel light-duty commercial vehicles (LCVs) will make it relatively more difficult for full BEV engine types to make rapid inroads in this region.

2.6.5 Segmentation by Fleet Size

There are two main segments in this dimension: Large commercial fleet customers and Small to Medium-Sized Enterprise (SME) buyers. The needs of fleet owners who have to service a large fleet of a hundred or more vehicles are quite different from the needs of SME owners who only have to service fewer than a dozen vehicles. There is a correlation between the degree of electrification in a fleet and the size of the fleet. Large fleets provide a fleet manager with greater flexibility in choosing an appropriate mixture of conventional and alternative power trains based on the specific needs for each application within their fleet. Vehicles with conventional engines can overcome the range limitations of electric vehicles in rural or lower density suburban areas (Schulz, Berlin, & Marker, 2010).

Large Fleet Size Segment – Fleet customers that fall into this classification include large private sector firms and large public sector agencies with more than 500 employees. These customers will typically purchase large numbers of vehicles (more than a dozen, often in the hundreds) and have a relatively heavy vehicle utilization schedule (Fildes, Nelson, Sener, Steiner, & Suntharasaj, 2007). Examples of organizations in this segment include logistics and parcel delivery firms (UPS, FedEx, DHL, Purolator), beverage firms (Coca-Cola, Pepsi), telecom and power utilities (AT&T, Verizon, Comcast, Qwest, Cox), and government agencies at all levels: federal (US Postal Service), state/provincial (California fleet) or municipal (City & County of San Francisco Motor Pool). With 86,095 vehicles, AT&T has the largest commercial fleet as shown in the chart of the largest US private sector fleet sizes in Figure 17. In the public sector, the US Postal Service has the largest fleet with 212,000 vehicles (Automotive Fleet Magazine, 2009). Depending on fleet needs with respect to duty class and application, fleet managers choose vehicles propelled by a variety of sources including ICE powertrains (gasoline, diesel, or natural gas) and HEV, PHEV, HHV or BEV powertrains.

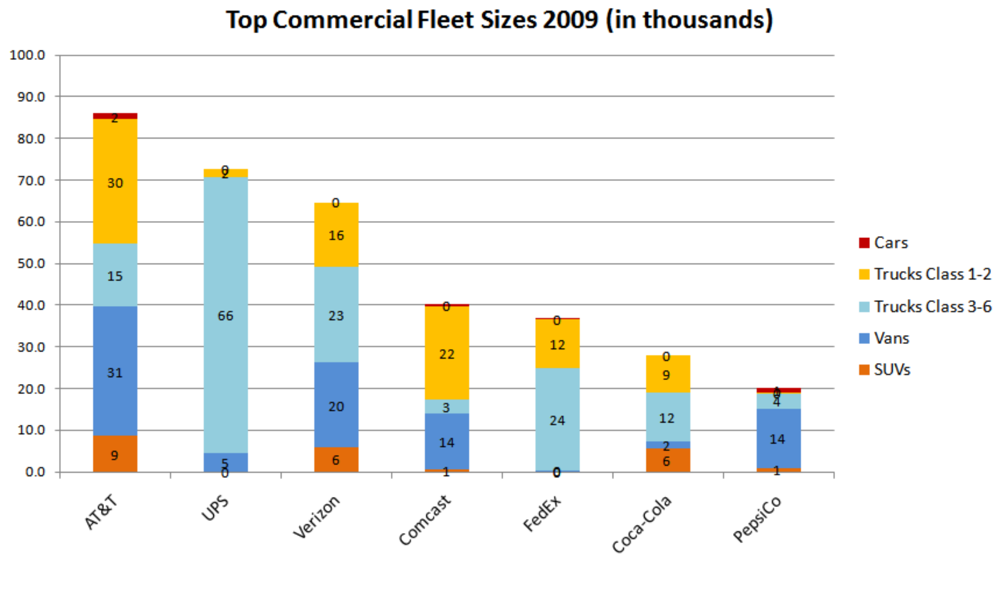


Figure 17 - Top US Commercial Fleet Sizes 2009
Source: Automotivotive Fleet Statistics automotive-fleet.com

Small and Medium-Sized Enterprise (SME) segment – Firms in this segment have fewer than 500 employees, and will operate small fleets (typically less than a dozen vehicles) as part of their business services. SME purchasers typically purchase vehicles one or two at a time once vehicles have been reached end-of-life and are due for replacement. Representative customer s in the SME segment would include businesses doing local delivery (florists, bakeries, couriers, and the like).

2.6.6 Segmentation by Sector

Fleet vehicles operate in nearly all sectors of the economy and are important for a number of industry sectors. Public sector (Government) fleets will have different mandates, performance criteria and cost targets than those of private fleets. For instance, public sector operators are not motivated by ZEV (zero-emission vehicle) tax credit incentives, as they are typically exempt from paying tax. However, many local governments have started to mandate the acquisition of fleet vehicles that meet or exceed more stringent or demanding emissions targets than those found in the private sector.

Private Sector - In 2009, corporate and commercial fleets in the private sector accounted the majority of fleet vehicles in operation (VIO), with a combined 74 percent market share (8.8 million and 3.2 million, respectively).

Public Sector - Public sector fleets at the federal, state and local level accounted for the balance, with approximately 4.4 million VIO. In terms of industry representation, short-haul delivery vehicles account for the largest share of U.S. fleet vehicles in operation, with 28 percent of the total market share. State and local government fleets are the second largest industry segment, representing nearly one-fourth of U.S. fleet vehicles in operation and the overwhelming majority of public sector vehicles. Passenger transportation applications such as rental cars, taxi fleets, school buses, and transit buses also account for a substantial share (16 percent of the total) (Electrification Coalition, 2010)

2.7 Value Proposition for Fleet Owners

There are several methods used by fleet managers to make purchase decisions when considering new spending on fleet vehicles or deciding which of several competing technology options is the best economic alternative. Two approaches frequently used by fleet managers to identify the value proposition are:

- **Total Cost of Ownership (TCO)** – the sum of capital and operating costs
- **Payback Period** – the time to recover the capital cost from operating cost savings

An overview of these methods is provided in Appendix A.

2.7.1 Cost model for TCO and Payback Period analysis by market segment

A spreadsheet cost model was created to identify which powertrain technology (ICE, HEV, PHEV, and BEV) has the lowest TCO and the fastest payback time. The projected TCO and payback time for each of the four technologies was compared while varying the acquisition year from 2011 to 2020. This set of sliding windows for vehicle lifetime was used to plot the TCO and payback time in 10 commercial vehicle segments classified by Duty Class, Utilization and Geographic Region. The technology with the lowest TCO (deemed the "TCO Advantage") and fastest payback at any given time is most likely to recoup the incremental costs and to be selected by the fleet manager. The TCO and payback period results are also used later in this report to predict the timing of adoption and the penetration rates for each technology within each segment.

2.7.1.1 TCO and Payback Model Scenarios

Each scenario for the cost model selects one of the four powertrain technologies (ICE, HEV, PHEV, and BEV), and one of eight commercial vehicle segments. Each segment is one of several combinations of Geographic Region, Duty Class, Utilization and Sector (Table 5).

Table 5 - Segment Classifications for TCO and Payback Analysis

Segment #	Geographic Region	Duty Class	Utilization	Miles/day (km/day)	Sector
1	North America	LCV	Short-Haul	40 (64.4)	Government
2	North America	LCV	Medium-Haul	70 (112.7)	Service
3	North America	MCV	Medium-Haul	70 (112.7)	Service
4	North America	HCV	Medium-Haul	100 (160.9)	Service
5	Europe	LCV	Short-Haul	40 (64.4)	Government
6	Europe	LCV	Medium-Haul	70 (112.7)	Service
7	Europe	MCV	Medium-Haul	70 (112.7)	Service
8	Europe	HCV	Medium-Haul	100 (160.9)	Service

Cost assumptions for the TCO and Payback model vary for each market segment and powertrain technology scenario, both for initial capital costs as well as for operating costs. Each scenario uses one of three cost forecasting likelihood options (optimistic, pessimistic, and most likely) that select profiles over the 2010-2030 period for those capital and operational cost elements which are most susceptible to change: battery costs, fuel prices, electricity prices, and maintenance costs. Details of model scenarios and assumptions are in Appendix C.

2.7.1.2 Analysis of TCO and Payback Model Findings

Total cost of ownership model

From Appendix D (graphs projecting TCO by market segment over the range of years from 2011-2020) the vehicle technology (ICE, HEV, PHEV, or BEV) with the lowest TCO for each year was identified for the most likely scenario. The results are shown in Table 6 (North America) and Table 7 (Europe).

	Technology with Lowest TCO by Market Segment			
Year	NorAm LCV Government	NorAm LCV Service	NorAm MCV Service	NorAm HCV Service
2011	ICE	ICE	BEV	HEV
2012	ICE	ICE	BEV	HEV
2013	ICE	ICE	BEV	HEV
2014	ICE	ICE	BEV	HEV
2015	ICE	BEV	BEV	HEV
2016	ICE	BEV	BEV	HEV
2017	ICE	BEV	BEV	HEV
2018	BEV	BEV	BEV	HEV
2019	BEV	BEV	BEV	HEV
2020	BEV	BEV	BEV	HEV

Table 6 – Technology with Lowest TCO Advantage by Segment – North America 2011-2020

	Technology with Lowest TCO by Market Segment			
Year	Europe LCV Government	Europe LCV Service	Europe MCV Service	Europe HCV Service
2011	BEV	BEV	BEV	HEV
2012	BEV	BEV	BEV	HEV
2013	BEV	BEV	BEV	HEV
2014	BEV	BEV	BEV	HEV
2015	BEV	BEV	BEV	HEV
2016	BEV	BEV	BEV	HEV
2017	BEV	BEV	BEV	HEV
2018	BEV	BEV	BEV	HEV
2019	BEV	BEV	BEV	HEV
2020	BEV	BEV	BEV	HEV

Table 7 – Technology with Lowest TCO Advantage by Segment – Europe 2011-2020

Based on this analysis, light-duty trucks with conventional ICE powertrains have the TCO advantage in North America in the short term but this switches to full battery electric trucks by 2015 in the service sector (medium haul daily utilization), and 2018 in the government sector (short haul daily utilization). The TCO advantage enjoyed by trucks with ICE powertrains in North America is primarily due to the relatively low US fuel prices. In Europe, where fuel costs are almost twice as high, the BEV powertrain technology already has the TCO advantage now in 2011.

In the medium-duty service truck market segment (MCVs) in both North America and Europe, BEV powertrain technology has the TCO advantage throughout the decade. An important reason for this is that the battery pack size is matched to the required range (sometimes referred to as right-sizing) without providing too much capacity at excessive cost. In this case, a typical range for a medium-duty delivery truck with a 65 kWh battery pack is 80 miles - sufficient to fulfill the demands for a daily vehicle utilization of 70 miles for the MCV service market segment.

In the heavy-duty truck market segment (HCVs), only hybrid trucks were compared to the conventional ICE powertrain (i.e. a BEV powertrain was not included). This is because the HCV long-haul service sector has a typical daily vehicle utilization of 160 miles (which exceeds the range of BEV vehicles). In this HCV segment, HEV hybrid trucks have a lower TCO than trucks with ICE powertrains in both North America and Europe for the entire 2011-2020 period.

Payback analysis

From Appendix E (graphs projecting payback period by market segment over the range of years from 2011-2020) the vehicle technology (ICE, HEV, PHEV, or BEV) with the fastest payback period for each year was identified for the most likely scenario. The results are shown in Table 8 (North America) and Table 9 (Europe).

Year	Technology with Fastest Payback Period by Market Segment							
	NorAm LCV Government	Payback Period (yrs.)	NorAm LCV Service	Payback Period (yrs.)	NorAm MCV Service	Payback Period (yrs.)	NorAm HCV Service	Payback Period (yrs.)
2011	BEV	12.8	BEV	8.2	BEV	4.2	HEV	4.2
2012	BEV	12.4	BEV	7.8	BEV	3.9	HEV	4.1
2013	BEV	11.8	BEV	7.4	BEV	3.6	HEV	3.9
2014	BEV	11.4	BEV	7.1	BEV	3.4	HEV	3.8
2015	BEV	10.9	BEV	6.8	BEV	3.2	HEV	3.6
2016	BEV	10.6	BEV	6.5	BEV	3.1	HEV	3.5
2017	BEV	10.3	BEV	6.3	BEV	2.9	HEV	3.4
2018	BEV	9.9	BEV	6.0	BEV	2.7	HEV	3.3
2019	BEV	9.6	BEV	5.8	BEV	2.6	HEV	3.2
2020	BEV	9.2	BEV	5.5	BEV	2.5	HEV	3.1

Table 8 – Technology with Fastest Payback Period by Segment – North America 2011-2020

Year	Technology with Fastest Payback Period by Market Segment							
	Europe LCV Government	Payback Period (yrs.)	Europe LCV Service	Payback Period (yrs.)	Europe MCV Service	Payback Period (yrs.)	Europe HCV Service	Payback Period (yrs.)
2011	BEV	8.3	BEV	5.2	HEV	1.9	HEV	2.4
2012	BEV	7.9	BEV	4.9	HEV	1.8	HEV	2.3
2013	BEV	7.5	BEV	4.6	HEV	1.7	HEV	2.2
2014	BEV	7.1	BEV	4.3	HEV	1.6	HEV	2.1
2015	BEV	6.8	BEV	4.1	HEV	1.6	HEV	2.0
2016	BEV	6.5	BEV	3.9	HEV	1.5	HEV	1.9
2017	BEV	6.2	BEV	3.7	HEV	1.5	HEV	1.9
2018	BEV	6.0	BEV	3.5	HEV	1.4	HEV	1.8
2019	BEV	5.7	BEV	3.4	HEV	1.4	HEV	1.8
2020	BEV	5.5	BEV	3.2	BEV	1.3	HEV	1.7

Table 9 - Technology with Fastest Payback Period by Segment – Europe 2011-2020

A value proposition based on minimizing the total cost of ownership by maximizing the fuel cost savings contribution is critical for selling successfully to commercial fleet truck markets.

2.8 North American and European Fleet Adoption Scenarios and Market Penetration of EV and HEV Technology

The previous section covered how Total Cost of Ownership will play a critical role in driving the electrification of commercial fleets. Changes in the relative TCO advantage for various powertrain technologies over time (as forecasted by the TCO and payback model) will affect the uptake of the xEV platforms in truck markets.

However, despite a potential TCO advantage, a recent study also expects that switching costs such as the vehicle driving range, infrastructure deployment challenges, and charging difficulty may be a deterrent to the adoption of electric drives in fleet applications, particularly for full BEV technology (Electrification Coalition, 2010). This study combined the level of switching difficulty and the relative TCO to predict the level of attractiveness of electric vehicles for different commercial fleet segments at a given point in time. The segments with the lowest switching difficulty and the highest TCO benefit will the segments most likely to have the highest adoption rate. Conversely, the segments with the highest switching difficulty and the lowest TCO benefit will have the lowest adoption rate.

In the theoretical approach of Everett Rogers regarding the diffusion of innovations, the market penetration of new technologies over the lifecycle of a technology can be estimated using S-curves or logistic function to represent the cumulative number of adopters (Rogers, 2003). More recently, S-curve logistic functions have been applied to predict the adoption or diffusion of technologies within the transportation industry, specifically for fuel cell markets (Hollinshead, Eastman, & Etsell, 2005).

Based on input received from technical experts and industry representatives, a series of PHEV market penetration scenarios were also presented in a recent study from the PNNL or Pacific Northwest National Laboratory (Balducci, 2008) are consistent with the adoption rates for the transportation technologies presented in the Hollinshead paper forecasting the market penetration of fuel cell vehicles

The Balducci report considered the adoption rates for four classes of alternative vehicles (although this considers the automotive sector rather than the trucking sector). The first alternative vehicles forecasted for adoption are E85 ethanol flex-fuel ICE vehicles, and gasoline-powered hybrid vehicles. By 2034, Balducci expects that hybrids and E85 vehicles will reach 50% market share for all new vehicles sold. Hybrids powered by diesel engines and plug-in hybrid variants trail the other hybrid technology by about four years. The FCEV (or hydrogen fuel cell electric vehicles) trail even further behind because of the time it takes to create the infrastructure for hydrogen refuelling and the time to build vehicle production. The Balducci report also assumes that all-electric battery vehicles (BEV) follow a similar adoption curve as the FCEV. This slow adoption rate of BEV vehicles is based on the amount of time to install proper electric charging infrastructure, and the extensive amount of effort required to develop cheaper

Li-Ion batteries and fast charging vehicle with sufficient range to satisfy most drivers (Balducci, 2008)

2.9 Supply Chain - Components, Powertrain Systems, and Vehicles

The components for a HEV, HHV, PHEV or BEV powertrain for a truck can be subdivided into three primary sub-systems: an energy storage system, a propulsion system, and the power electronic control systems and software. Depending on the type of powertrain technology (HEV, HHV, PHEV or BEV) employed, all of the subsystems offer various approaches to component selection and design. For example, the system designer of a xEV vehicle might choose from lithium-ion, lead-acid or nickel-metal hydride batteries for a typical energy storage system. For hydraulic hybrids (HHV), stored potential energy is provided by compressed fluid in an accumulator. For HEV and PHEV trucks, the propulsion system is provided by a traction motor working in tandem with an ICE engine. For a hydraulic hybrid, the propulsion power is provided by an ICE engine in tandem with a hydraulic pump / impeller.

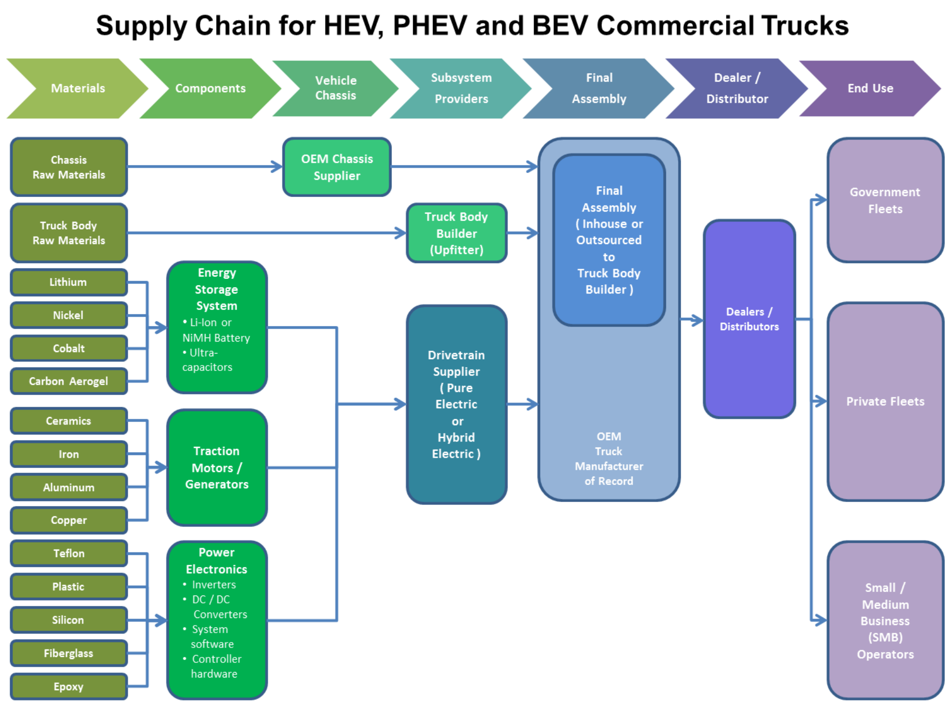


Figure 18 - Supply Chain for HEV, PHEV and BEV Commercial Trucks
Source: Adapted from (Lowe et al., 2009)

A typical supply chain for HEV, PHEV and BEV commercial vehicles is shown in Figure 18 above. This industry supply chain model was adapted from a study of the value chain for hybrid-electric drivetrains by the Centre on Globalization Governance & Competitiveness (Lowe et al., 2009). The model above further adapts the CGGC model to support PHEV and BEV vehicle drivetrains as well. There are new component categories in this supply chain that are not typically found in a conventional truck manufacturing supply chain including traction motors, battery packs, DC-DC converters, and other components. From the inputs on the left to the outputs on the right, the supply chain is divided into the following columns for materials, components, truck chassis manufacturers, drivetrain providers, final assembly, dealers/distribution, and end users. The generic supply chain framework here was adapted to describe the company-specific supply chain for Azure Dynamics' outsourced manufacturing strategy discussed later in detail in section 4.1 of the internal analysis.

In the area of lithium-ion battery technology, many new battery suppliers are working independently, in strategic alliances or in joint ventures with large Tier 1 auto manufacturers. These alliances are trying to find innovative ways to package and integrate battery cells into battery packs while reducing manufacturing costs and exploiting economies of scale. These battery pack technologies will be critical to the optimal performance of HEV, PHEV and EV trucks (Goldman Sachs, 2010). Figure 19 shows some of these complex relationships.

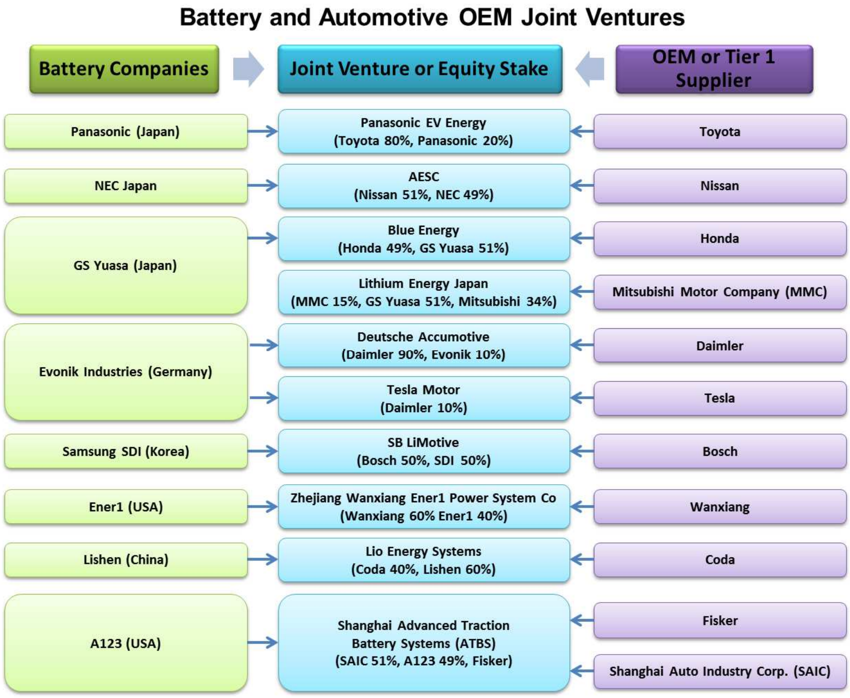


Figure 19- Strategic Alliances Between Battery Companies and Tier 1 Auto Manufacturers and OEMs Source: (Goldman Sachs, 2010)

3 Attractiveness of the Commercial Electric Vehicle Industry

This chapter first surveys the competition in the commercial electric vehicle industry. Next, an analysis of the North American and European commercial electric vehicle market is presented. Finally, this chapter synthesizes the external analysis into key success factors for the commercial hybrid and electric vehicle markets.

3.1 Competition in the Commercial Electric Vehicle Industry

Different groups of firms compete at each stage of the electric vehicle industry's value chain as described in the previous section 2.9.

HEV, PHEV and BEV vehicle markets are relatively fragmented and dispersed. Many small and large vehicle manufacturers have introduced a variety of hybrid-electric, hydraulic-hybrid and all-electric vehicle technologies targeted at both consumer and commercial markets. While Azure is currently positioned in the Class 1-3 light-duty (LCV) and Class 4-5 medium-duty (MCV) segments of the truck industry, most other alternative powertrain industry competitors to Azure Dynamics currently participate in one side or the other. Some participate in an even lighter segment than Class 1 trucks such as the consumer automotive segment, while others participate in a heavier duty class segment such as the Class 6-8 heavy duty HCV truck segment. Major automotive OEMs (including Toyota, Honda, General Motors, Ford and Nissan) are concentrating heavily on the consumer automobile market segment for HEV, PHEV and BEV vehicles. Conversely, most major truck OEMs (such as Daimler/Freightliner, PACCAR, Volvo, International and component manufacturers and system integrators such as Eaton Corporation) are focused on the heavy-duty HCV truck market segment.

At this time, there is no dominant design for alternative powertrain technologies to the internal combustion engine (ICE). However, the emergence of a dominant design in alternative powertrain technologies is inevitable as the industry matures. The core competencies of vehicle suppliers will play a role.

Competition within the automotive industry to produce commercial hybrid electric vehicles (HEV) and plug-in electric vehicles (PHEV and BEV) is intense and continued to accelerate during 2011. However, there is recent evidence of industry consolidation because of the relatively high cost of lithium-ion batteries and low cost of oil as a substitute source of energy. Several relatively small development stage EV firms such as Think Global, Modec (UK), Ener1, Bright Automotive, Aptera Motors and now Azure Dynamics have filed for bankruptcy protection over the last year.

Azure Dynamics is vertically integrated to a certain extent across three of the stages of the value chain, where it produces:

1. High power inverter modules (the component stage),
2. Hybrid electric and battery electric powertrains under Azure's Force Drive brand (the subsystem stage) and
3. The medium-duty Balance E-450 Hybrid Electric Step Van and the light-duty Transit Connect Electric vehicles (the final assembly stage).

Up until 2011, Azure Dynamics' Force Drive™ inverters and electric powertrain components and subsystems were sold as a separate product line. However, by the 3rd quarter of 2011, Azure phased out the sale of the Force Drive product line externally, deciding instead to focus on providing components solely for integration into Azure's own vehicle platforms. Thus, this profile of the competitive landscape focuses on competitive firms at the final assembly stage.

A diagram of the competitive landscape is shown in Figure 20. Note that the groups of competitors are classified (a) by duty class including the light-duty commercial vehicle (LCV) and medium-duty commercial vehicle (MCV) segments where Azure participates as well as heavy-duty vehicle (HCV) and bus segments, and (b) by technology class (hybrid HEV, plug-in battery electric (BEV), or conventional ICE powertrains).

xEV Commercial Electric Vehicle Competitive Landscape

	Passenger Vehicles (for comparison purposes)	Commercial Vehicles: LCV Class 1-2 Light Duty	Commercial Vehicles: MCV Class 3-6 Medium Duty	Commercial Vehicles: HCV Class 7-8 Heavy Duty	Commercial Vehicles: Transit Buses
Major Fleet Applications		Parcel Delivery Vans Trades / Services Vans	Parcel Delivery Vans Beverage Trucks Trades / Services Vans Utility / Telecom (Bucket Truck) Refuse Shuttle Bus	Beverage Trucks Utility / Telecom (Bucket Truck) Refuse Shuttle Bus	
Hybrid Electric Vehicle (HEV) and Hydraulic Hybrid Vehicle (HHV) Competitors	• Ford Fusion & Escape • Chevy Volt / Opel Ampera • Nissan Altima • Honda Insight • Toyota Prius, Highlander • Hyundai Sonata, Elantra • Mercedes S400, ML350 • Volvo V70 PHEV • Chevy Yukon / GMC Tahoe	• Iveco EcoDaily Diesel Electric Van • Chevy Silverado / GMC Sierra pickup • Via Motors Vtrux PHEV pickup	• **Azure Dynamics Balance Step Van** • **Azure Dynamics Balance Shuttle Bus** • **Azure Dynamics Ford F-450 SD PHEV Utility Truck (in development)** • Freightliner MT-45 / Eaton E700 Step Van • Hino 195h Cargo Van • Isuzu N-Series Cargo Van • Mitsubishi Canter Cargo Van • Nissan e-NT400 Cabstar Cargo Truck • Renault Maxity Cargo Van • Freightliner MT-55 / Parker-Hannifin / Morgan Olson Hydraulic Hybrid Step Van	• Freightliner/Eaton M2e Utility Truck • Kenworth/Eaton T270/T370 Delivery & Utility Truck • Mercedes Benz Atego Truck • Navistar/Eaton DuraStar Beverage / Utility / Refrig. Truck • Navistar/Eaton WorkStar Utility Truck • Dueco / Odyne Bucket Truck • Peterbilt/Eaton Models 330 / 337 /348 / 386 (City Delivery / Fire / Beverage / Municipal / Refuse / Utility Truck) • Renault Hybrys Beverage Truck • McNeilus ZR Series Refuse Truck with Eaton Hydraulic Hybrid powertrain	• BAE / Allison Hybrid Bus • Blueways / ISE Hybrid Bus • Iveco Hybrid Bus • Orion Hybrid Bus • International / Enova Hybrid Bus • Volvo Hybrid Buses • Wrightbus
Battery Electric Vehicle (BEV) Competitors	• Renault Fluence ZE • Nissan Leaf • Mitsubishi Miev	• **Azure Dynamics Transit Connect Electric** • E-Wolf Delta Fleet Van • Opel / GM Vivaro eConcept Van • Iveco EcoDaily Electric Van • Mercedes Benz Vito e-Cell Van • Mitsubishi Miev Electric Van • Nissan e-NV200 Electric Van • Renault Kangoo ZE Electric Van • Smith Edison Electric Van	• BoulderEV DV500 Step Van • Freightliner MT-45 / Enova ZE Step Van • EVI WI Electric Walk-In Van • EVI MD Electric Cargo Van • E-Wolf Omega 14 Cargo Van • Freightliner / Enova / Morgan Olson MT-EV Step Van • Smith Newton Electric Cargo Van • Smith Newton Electric Step Van • Navistar eStar Step Van • Zerotruck All Electric MD Truck	• Balqon Nautilus XE30 Zero Emission Port Terminal Drayage Truck	• Proterra EcoRide BE35
Conventional Gas/Diesel (ICE) Vehicle Competitors	• Ford • GM • VW • Renault / Nissan • Honda • Fiat / Chrysler • Toyota • Daimler etc....	• Mercedes-Benz Sprinter Van • Ford E-Series Van • Ford Transit 2013 T-Series Van • Nissan NV Van • Nissan NV200 / Renault Trafic / Opel Vivaro Van • Nissan NV400 / Renault Master / Opel Movano Van • Fiat Ducato / Dodge Ram 2014 / Peugeot Boxer Van • Chevrolet Express / GMC Savana Van	• Utilimaster Reach CV-23 Step Van with Isuzu chassis • Morgan Olson Sprinter Urban Delivery Vehicle (UDV) Step Van • Morgan Olson Route Star Step Van with Freightliner MT-45 chassis • Utilimaster AeroMaster Step Van with Ford E450 Ford Chassis • Utilimaster W700 Optifleet Step Van on Freightliner MT-45 Chassis • Mercedes Benz Vario • Navistar Step Van on Workhorse Custom Chassis W42	• Daimler AG (Mercedes-Benz, Freightliner, Sterling, Fuso) • Volvo Group (Volvo, Mack, Renault) • Toyota Group (Hino Motors, Isuzu) • Navistar/International • Fiat Group (Iveco) • PACCAR (DAF, Kenworth, Peterbilt, Leyland) • VW/Scania/MAN SE	• Daimler Bus • Hino Bus • Hyundai Bus • Isuzu Bus • Iveco Bus • MAN Bus • New Flyer Bus • North American Bus Industry (NABI) • Scania Bus • Volvo Bus etc...

Figure 20 - xEV Commercial Electric Vehicle Landscape

3.1.1 Light-duty Commercial Vehicle (LCV) Competitors

In the light-duty commercial vehicle (or truck) market, there exist a small number of large companies, between whom competition is fierce. Table 10 lists LCV competitors who provide HEV and BEV light-duty vehicles (mainly panel vans) which compete with Azure's Transit Connect Electric product.

Following the economic downturn that has been experienced on a global scale (most notably GM and Chrysler), the situation has improved due to strong growth in 2010, which tends to ease rivalry. The large OEMs that sell conventional trucks in the LCV market are typically diversified across all areas of the automotive market (e.g. passenger cars, light, medium and heavy trucks) and this minimizes their exposure to downturns in any one segment in particular. The most notable competitor to Azure at this time is Nissan with the e-NV200 electric van, which has started field trials with the New York City taxi fleet (Table 11).

Truck Supplier	Model	Date / Status	Powertrain	Battery	Chassis OEM	Payload	Range
Azure Dynamics	Transit Connect Electric Van	2010 - Concept 2011 - Production	Azure Dynamics	Johnson Controls Inc.	Ford Transit Connect	500 kg	130 km
GM / Opel / Vauxhall	Vivaro eConcept Electric Van	2011 – Concept (Renault Trafic / Nissan NV300 Primastar)	GM	LG Chem	GM	750 kg	100 km
Mercedes Benz	Vito E-Cell Electric Van	2011 - Concept	MB	Tesla	MB	900 kg	130 km
Mitsubishi	MINICAB-Miev Electric Van	2010 – Concept 2011 - Production	Mitsubishi	Toshiba	Mitsubishi	350 kg	100 km
Nissan	e-NV200 Electric Van	2012 - Concept	Nissan	AESC – Auto. Energy Supply Corporation	Nissan	750 kg	160 km
Renault	Kangoo ZE Electric Van	2008 – Concept 2011 - Production	Renault	AESC – Auto. Energy Supply Corporation	Renault	650 kg	170 km
Iveco	ECODaily Electric Van	2010 – Concept 2012 - Production	Bosch	Johnson Controls Inc.	Iveco	800 kg	130 km
Smith Electric Vehicles	Edison Electric Van	2009 – Concept 2010 - Production	Enova	A123 Systems Valence Tech.	Ford Transit	950 kg or 1100 kg	90-180 km

Table 10 - Competitors to Azure Dynamics for All-Electric BEV Light-duty Commercial Vehicles (LCV)

The medium-duty truck market has some large multinationals such as Tata Motors, Beiqi Foton Motor, FAW, and Daimler AG. These four account for just over 30% of the global market volume. Another smaller competitor Enova Systems develops electric powertrain components for MCV and HCV markets, and has an alliance partnership with Hyundai Heavy Industries. With no one firm enjoying price-setting power, competition on price is expected to be intensified. However, greater concentration can be observed in specific countries.

Truck Supplier	Model	Type	Powertrain	Battery	Body Builder	Chassis OEM	Fuel	GVW (lb.)	Class
Azure Dynamics	Balance Hybrid Step Van	HEV	Azure Dynamics	Johnson Controls Inc.	Utilimaster	Ford E-450	Gasoline	14,000	5
BoulderEV	DV-500 Electric Van	BEV	–	–	BoulderEV	BoulderEV	Electric	n.a.	5
EVI Electric Vehicles Intl.	EVI-WI Med Duty Electric Step Van	BEV	EVI	Valence Technology	Morgan Olson / Route Star	Freightliner MT-45	Electric	n.a.	5
Freightliner Custom Chassis (FCCC)	MT-45	HEV	Eaton	LG Chem	Utilimaster / E700 Optifleet	Freightliner MT-45	Diesel	16,000	5
Freightliner Custom Chassis (FCCC)	MT-55	HHV	Parker-Hannifin	n/a (hydraulic)	Morgan Olson	Freightliner MT-55	Diesel	20500-27000	6
Freightliner Custom Chassis (FCCC)	MT-EV	BEV	Enova	Tesla	Morgan Olson / CV-23	Freightliner MT-45	Electric	n.a.	5
Freightliner Custom Chassis (FCCC)	ZE Truck	BEV	Enova	Valence Technology	Morgan Olson / Route Star	Freightliner MT-45	Electric	n.a.	5
Navistar, Inc.	eStar	BEV	Zytek	A123 Systems	Navistar / Leeward Truck Bodies	–	Electric	12,100	4
Smith Electric Vehicles	Newton Step Van	BEV	Enova	A123 Systems	Utilimaster	–	Electric	n.a.	5

Table 11 – Competitors to Azure Dynamics for Class 4-6 Medium-duty (MCV) Hybrid and Electric Walk-in Vans

A list of medium duty cargo vans and shuttle buses is shown in Table 12. The most significant competitor in this area is Hino in the cargo van area with the 195h hybrid diesel truck, which was introduced in North America in 2011, and the Smith Electric Vehicles Newton all-electric truck.

Truck Supplier	Model	Type	Powertrain	Battery	Application	Fuel	GVW (lb.)	Class
Azure Dynamics	Balance E-450 Hybrid	HEV	Azure Dynamics	Johnson Controls Inc.	Shuttle Bus, Cargo Van	Gasoline	14,000	5
Nissan	e-NT400 Cabstar	HEV	Nissan	AESC	Cargo Van	Diesel	n.a.	4
Electric Veh. Intl.	EVI-MD Electric Truck	BEV	EVI	Valence Tech.	Cargo Van	Electric	n.a.	5
Hino	195h Hybrid	HEV	Hino	Primeart h EV	Cargo Van	Diesel	n.a.	5
Isuzu	N-Series Hybrid Truck	HEV	–	Hitachi	Cargo Van	Diesel	n.a.	5
Mercedes Benz	Atego Bluetec Hybrid	HEV	Eaton	Evonik	Cargo Van	Diesel	n.a.	5
Mitsubishi Fuso	Canter E-CELL	BEV	–	Hitachi	Cargo Van	Electric	n.a.	5
Mitsubishi Fuso	Canter Eco Hybrid	HEV	–	Hitachi	Cargo Van	Diesel	n.a.	5
Smith Electric Vehicles	Newton	BEV	Enova	A123 Systems	Food Distribution, Parcel Delivery, Chilled Food Distribution, Short Haul, Utility, Airport Operations, School Bus	Electric	16,535-26,455	5
Zerotruck	Electric Van	BEV	UQM	Dow Kokam	Cargo Van	Electric	14,500	4

Table 12 - Competitors to Azure Dynamics for Class 4-6 Medium-Duty (MCV) Hybrid and Electric Cargo Vans, and Shuttle Buses (excluding Walk-in Vans)

3.1.2 Heavy-duty Commercial Vehicle (HCV) Competitors

Although the HCV segment is not current a segment of the commercial truck manufacturing market in which Azure Dynamics currently participates, there are a number of OEM truck manufacturers that provide hybrid electric vehicle (HEV) or even battery-electric vehicle (BEV) technology for class 7-8 trucks. Table 13 lists some HEV and BEV products in the HCV segment. BAE Systems and ISE Corporation have electric and hybrid electric powertrains for HCV trucks, large city transit buses, and large military vehicles. Eaton develops hybrid electric and hybrid hydraulic powertrains for both MCV and HCV markets.

Truck Supplier	Model	Type	Powertrain	Battery	Application	Fuel	GVW (lb.)	Class
Kenworth	T270	HEV	Eaton	LG Chem	Delivery, Utility	Diesel	25,000	6-7
Navistar, Inc.	DuraStar Hybrid	HEV	Eaton	LG Chem	Beverage, Box Van, Refrigeration, Landscape Dump, Utility, Crane, Tree Trimmer, Recovery Towing, Armored Vehicle, Stake Flat, Grapple, Road Patch Truck, Refined Fuels	Diesel	23,500-39,000	6-7
Navistar, Inc.	WorkStar Hybrid	HEV	Eaton	LG Chem	4x4 Utility, Landscape Dump, Snowplow, Digger Derrick, Utility, Crane, Stake Flat, Box Van, Towing, Refined Fuels	Diesel	23,500-39,000	6-7
Peterbilt	330 Hybrid	HEV	Eaton	LG Chem	Delivery van	Diesel	26,000	6-7
Peterbilt	337 Hybrid	HEV	Eaton	LG Chem	City Delivery, Fire/Rescue, Beverage, Municipal, Refuse, Utility	Diesel	n.a.	6-7
Volvo / Renault Trucks	Hybrys	HEV	–	AESC	Cargo Van, Beverage Truck	Diesel	n.a.	7
Freightliner	Business Class M2e	HEV	Eaton	LG Chem	City Delivery, Utility, Delivery Tractor	Diesel	Up to 55,000	7
Kenworth	T370	HEV	Eaton	LG Chem	Delivery, Utility	Diesel	33,000	7
Navistar, Inc.	4300	PHEV	Dueco/Odyne		Utility, Digger Derrick, Air Compressor	Diesel	Up to 37,000	7
Peterbilt	348 Hybrid	HEV	Eaton	LG Chem	Municipal, Service, Utility	Diesel	33,000+	7
Mack/Volvo	TerraPro Hybrid	–	–	–	Refuse	Diesel	n.a.	8
Peterbilt	320 Hybrid	HHV	Eaton HLA	n/a (hydraulic)	Refuse	Diesel	n.a.	8
Peterbilt	386 Hybrid	HEV	Eaton	LG Chem	Long Haul	Diesel	n.a.	8

Table 13 - Competitors for Class 7-8 Heavy Duty (HCV) Hybrid and Electric Trucks (outside of Azure Dynamics' current chosen market segments)

3.1.3 Sample Competitor Profiles

Sample Competitor	Smith Electric Vehicles
	Smith Electric Vehicles (SEV) supplies medium-duty commercial electric vehicles for commercial fleet operators in the United States and Europe with predictable daily routes of less than 120 miles, returning to the same depot location each evening.
Location of Headquarters	Kansas City, Missouri
Number of Employees	310 employees: 94 production: 40 Engineering, 17 Sales/Marketing: 118 service, 44 admin.
Facilities	Kansas City, Missouri; Newcastle, UK; New York, NY (commencing 2012 Q3)
Products	**Newton Cargo Van** - All-electric truck in the medium-duty (MCV) Class 5-7 range weighing 14,000 to 26,400 pounds GVW (see Table 12). The truck has a range of 100 miles (160km) on a single charge of the Li-ion batteries supplied by A123 Systems. The top speed is 50 mph. There are many Newton body styles: cargo van, flatbed, school bus, utility truck, and parcel delivery step van. **Newton Step Van** - The Newton Step Van was announced in March 2012 and is based on Smith's existing Newton platform (see **Table 11**). It was developed in collaboration with Utilimaster, an Indiana-based truck body builder. The Newton Step Van has up to 1,200 cubic feet (33.9 cubic meters) of cargo capacity and up to 10,000 pounds (4,535 kg) of payload. The lead customer for the Newton Step Van is FedEx Express **Edison** - An all-electric light commercial vehicle (LCV) built on the full-size Ford Transit Class 2c van weighing 7,700 to 10,000lbs GVW (see **Table 10**). The Smith Edison is available in panel van, chassis cab or minibus configurations. The truck has a range of 55-110 miles (90-180km) and a top speed of 50mph (80km/h). Edison uses a Li-ion battery from Valence Technologies that recharges in 8 hours. Edison includes a fast-charger option to recharge batteries in four hours.
Company History and Financing	Smith Electric Vehicles (USA) was founded in 2009 and merged with Smith Europe in January 2011, when Smith EV USA acquired the business of Smith UK from Tanfield plc.
Ownership	Privately held; IPO is expected in late 2012. SEV raised $40 million in private capital in the first quarter of 2012 including $20 million investment from Wanxiang China.
Annual Revenue	During the fiscal years 2009, 2010 and 2011, SEV had revenue of $22.9 million, $35.6 million and $49.9 million, and incurred net losses of $17.5 million, $30.3 million and $52.5 million, respectively.
Main Customers	Large fleet operators in food & beverage, utility, telecom, retail, grocery, parcel delivery, schools, military and government. Important customers include Coca-Cola, FritoLay, Staples, Sainsbury (UK), FedEx, DHL, TNT, and the US Marine Corps.
Business Model	SEV's focuses on three elements in their model... (a) developing advanced vehicle technologies, (b) manufacturing vehicles using a decentralized, low cost assembly strategy, and (c) gaining leverage from customer advocates to accelerate the adoption of SEV electric vehicles, using a differentiated approach to commercial vehicle sales and service
Sales and Distribution Strategies	SEV uses a direct sales force, and a limited 3rd party distribution network. SEV's approach involves a lifecycle approach to deployment, servicing and replacement of SEV electric vehicles tailored to the individual needs of SEV's customers.
Partners and Alliances	**A123 Systems** - Supplies 5kWh Li-ion battery modules. SEV also has the option to buy individual cells to enable SEV to configure different size battery packs. **Avia Ashok Leyland Motors** - Supplies the chassis and cab on which SEV's Newton platform is based. SEV has exclusive rights to sell electric trucks using the Avia platform for the US market. **Wanxiang Group** – In Feb. 2012. SEV announced a $25 million equity investment in Smith by China-based Wanxiang Group and a $75 million investment in a joint venture between Smith and Wanxiang Group to develop manufacture and commercialize all-electric school buses and commercial vehicles for multiple industries in China. Wanxiang Group is China's largest automotive components manufacturer. **Ford Motor Co.** – Ford supplies the glider chassis for the full-size Class 2c Ford Transit van to SEV for integration in the SEV Edison van (along with Smith Drive components).

Sample Competitor	Renault / Nissan
	Renault-Nissan Alliance is a strategic partnership between Paris-based Renault and Yokohama, Japan-based Nissan, which together sell more than one in 10 cars worldwide. Of the major manufacturers, Nissan has been the most aggressive in promoting electric vehicles not only in the United States but also around the world. Nissan launched the 2011 Leaf EV in the U.S. market at the very end of calendar year 2010. Nissan has also implemented full hybrid technology with the Altima Hybrid. In 2011, the alliance introduced new vehicles employing the same Leaf technology to the commercial LCV van markets.
Location of Headquarters	Renault: Boulogne-Billancourt Cedex, France, Nissan: Tokyo, Japan
Number of Employees	Renault: 122,615
Facilities	Cleon, Normandy, France; Cergy-Pontoise, France; Le Puy, France; Flins Mans Avtoframos, Moscow, Russia; Santa Isabel, Cordoba, Argentina; Chennai India
Products	**Renault Kangoo Express ZE Light Van.** – This all-electric BEV mini-van was introduced in 2010 and entered production at the Maubeuge plant in late 2011. Initial sales were made in Israel and Denmark using the Better Place battery swapping dealer network. In late 2011, Renault was awarded a contract to supply 15,600 Kangoo ZE vehicles to the French Government and the state-owned postal service, La Poste. European pricing is approx. €20,000 before government incentives and excluding VAT. In addition to buying or leasing the vehicle there is a separate monthly subscription costing €72 for the battery. **Nissan e-NV200 Electric Van** The Nissan e-NV200 LCV electric van concept was introduced at the North American International Auto Show (NAIAS) in Detroit in Jan 2012. It has an estimated driving range of 100 miles/160 km per charge, with the same cargo capacity as the current ICE NV200. **Nissan e-NT400 Cabstar Hybrid Cargo / Refrigerated Van – T**his LCV class 3 hybrid concept van was launched at the 2011 Tokyo Truck show. When the e-NT400 Cabstar enters production, Renault and Opel may rebadge and sell it under the Renault Master / Opel-Vauxhall Movano nameplate. **Opel Vivaro eConcept Van** – The e-Concept debuted in September 2010 at the IAA Commercial Vehicle Show in Hanover, Germany. It is plug-in hybrid vehicle, with an extended range of up to 250 miles (400 km) and includes 21 kWh lithium ion batteries enabling a range of 60 miles (97 km. If the Opel Vivaro e-Concept enters production, Renault and Nissan could decide to rebadge and sell it under their Nissan NV300 Primastar / Renault Trafic platform brand.
Partners and Alliances	**Better Place** - In 2008, Renault and Nissan announced that their will form a strategic partnership with Better Place to secure the capability for swapping vehicle batteries for their forthcoming electric vehicles. Better Place operates a network of charging locations and battery replacement stations in Israel and Denmark, and soon in other countries. **Automotive Energy Supply Corporation (AESC)** – In May 2008, as part of the zero emission strategy, the Renault Nissan alliance formed a joint-venture company with NEC called Automotive Energy Supply Corporation (AESC) to develop and produce advanced lithium-ion batteries for a wide range of automotive applications from hybrids, electric vehicles to fuel-cell vehicles. **GM Europe / Opel** - For light commercial vehicles, Renault and GM Europe signed a cooperative agreement in 1999. The agreement provides for: • The supply of Renault Master (produced by Renault at Batilly) to GM Europe. The vehicles are rebadged under the Opel/Vauxhall Movano nameplate. In May 2010, the Renault Master / Opel Movano platform is produced and shared by Nissan under the NV400 badge. • The development and joint manufacture of the Renault Trafic/ Opel-Vauxhall Vivaro range. Under the agreement, Renault is responsible for design and development and supplies the engines, while GM handles manufacturing at its IBC plant in Luton, UK. Nissan's Barcelona, Spain plant also began producing this vehicle in September 2002 under the name NV-300 Primastar.

Sample Competitor	Daimler Trucks North America / Freightliner Trucks / Freightliner Custom Chassis Corporation / Mitsubishi Fuso
	Daimiler AG is a German firm with several subsidiary brands that manufacturer commercial vehicles including Freightliner Trucks, Freightliner Custom Chassis Corporation, Western Star, Orion Buses, Thomas-Built Buses, and Mitsubishi Fuso. Daimler Trucks North America (DTNA), a subsidiary of Daimler AG, is the largest manufacturer of heavy-duty trucks in North America with annual earnings of over $32 and over 22,000 employees. Daimler and DTNA have several divisions including: **Freightliner Trucks and Western Star** - known mainly for heavy-duty long-haul class 8 diesel trucks, as well as class 5-7 trucks for local and regional distribution, construction and services. **Freightliner Custom Chassis Corporation (FCCC)** –manufacturers and sells delivery vans, recreational vehicles and shuttle buses. **Mitsubishi Fuso** - Light-, and medium trucks for distribution and goods transportation, construction, and industrial services
Location of Headquarters	Portland, Oregon (HQ for Daimler Trucks North America)
Number of Employees	Daimler Group AG (worldwide 260,000), Daimler Trucks NA (24,000)
Facilities	Cleveland, NC: Freightliner Class 8 trucks including Cascadia, Century Class, Columbia High Point, NC: Thomas Built Buses Mount Holly, NC: Freightliner medium-duty Business Class M2 models Portland, OR: Western Star 4900 EX, 4900 SA, 4900 FA and 6900 XD trucks Gaffney, SC: Freightliner Custom Chassis Corporation. Custom chassis for motorhomes, delivery vans, shuttle buses, and school buses. Redford, MI: Detroit Diesel: Engine production Santiago Tianguistenco, Mexico: Freightliner Business Class M2 medium-duty trucks; Freightliner's heavy-duty models, including the FLD Series, Century Class, Columbia and Coronado. Saltillo, Mexico: Freightliner Cascadia Class 8 Trucks
Products	**Freightliner MT-EV Electric Step Van** Produced in partnership with Morgan Olson and Enova Systems (**Table 11**). **Ze Electric Step Van** Freightliner produced ZE in partnership with Enova Systems and Morgan Olson. Based on FCCC MT-45 chassis and Morgan Olson Route Star body **(Table 11**). **Freightliner E700 Optifleet Hybrid Step Van** Produced in partnership with Utilimaster and Eaton – uses FCCC MT-45 Chassis (**Table 11**). **Freightliner M2e Hybrid Utility Truck-** HCV hybrid (Table 13) **Mercedes Atego Bluetec Hybrid Truck** – MCV Hybrid cargo van (Table 12) **Mercedes-Benz Vito E-Cell Electric Van** – Light-duty BEV panel van (**Table 10**) **Mitsubishi Fuso Canter Eco Hybrid** **Mitsubishi Fuso Canter E-CELL**
Annual Revenue	Daimler sold 196,651 medium & heavy trucks globally in 2010 giving the company a market share of 15.7%. This establishes Daimler's position as the leading brand in the Medium & Heavy truck sector.
Partners and Alliances	Hitachi Vehicle Energy supplies batteries for Mitsubishi Fuso Canter Trucks.

Sample Competitor	Navistar International Trucks / Workhorse Custom Chassis
	Navistar International Corporation (formerly International Harvester Company) is a US-based holding company that owns International trucks, MaxxForce brand diesel engines, IC Bus school and commercial buses, Workhorse brand chassis for motor homes and step vans, and is a private label designer and manufacturer of diesel engines for the pickup truck, van and SUV markets. The company is also a provider of truck and diesel engine parts and service.
Location of Headquarters	Lisle, Illinois
Number of Employees	14,800
Facilities	Lisle, IL, Melrose Park, IL, Fort Wayne, IN, Madison Heights, MI, Columbia, SC
Products	**Navistar eStar Truck** – Medium-duty (MCV) electric walk-in van (**Table 11**). **International DuraStar Hybrid** – Heavy-duty (HCV) hybrid vocational truck (Table 13) **International Workstar Hybrid** – Heavy-duty (HCV) hybrid vocational truck (Table 13) 4300 Hybrid (Dueco / Odyne partners) – Utility truck, digger / derrick truck (Table 13)

Sample Competitor	Eaton Corporation
	Eaton Corporation manufactures electrical and hydraulic components and systems for power quality, power distribution, industrial and mobile equipment, aerospace, and truck and automotive industry sectors.
Location of Headquarters	Cleveland, Ohio
Number of Employees	73,000
Facilities	RoadRanger Truck Components Operations, Galesburg, Kalamazoo County, MI: 600 employees
Powertrain Products	The truck components group supplies RoadRanger brand hybrid-electric and hydraulic powertrains: • 6E706B-SV Medium–Duty Step Van (HEV) • 8E306A-CD Medium-Duty City Delivery Truck (HEV) • HLA Refuse Truck (Hybrid Hydraulic) • 8E406A-UP Medium–Duty Utility Truck with ePTO (HEV) • 8E406A-P Medium-Duty Shuttle Bus (HEV) • 6E706B-PSB School Bus (HEV)
Company History and Financing	Founded in 1911 as Torbensen Gear and Axle; Changed its name to Eaton Axle and Spring in 1923. In 2007, Eaton and PACCAR (holding company for Peterbilt and Kenworth trucks) entered into an agreement to jointly develop hybrid technology for heavy-duty commercial vehicles in North America. In 2008, Eaton introduced its first hybrid bus with Beiqi Foton Bus in China. So far, 230 diesel-electric hybrid buses have been delivered to Guangzhou Yiqi Bus.
Ownership	Public (NYSE: ETN)
Annual Revenue	The company recorded revenues of $16,049 million USD in FY2011. The net profit was $1,350 million. The truck segment FY2011 revenues were $2,644 million, an increase of 32% over FY2010. The increase in truck segment sales reflected the rebound in global markets, in particular strong growth in the Class 8 truck market in North America and Brazil.
Main Customers	More than 5,500 Eaton hybrid electric and hybrid hydraulic systems have been deployed so far, accumulating an estimated 200 million miles of service. In 2011, two-thirds of the truck segment's sales were made to the top 5 customers including Daimler, Freightliner, Ford, International, and PACCAR (Kenworth and Peterbilt). Other customers include Crane Carrier Corp., DAF, Iveco, Foton, JNP, King Long, Solaris, Tata, YoungMan, Yutong and Zhongtong. Large fleet customers using walk-in vans and delivery trucks with Eaton powertrains include FedEx, UPS, Coca-Cola Enterprises and PepsiCo. Many utility and telecom firms across North America (e.g. Florida Power and Light) use work trucks with Eaton hybrid power. Transit fleets in Asia, Europe, the Middle East and South America use buses with Eaton hybrid power.
Sales and Distribution Strategies	Sells powertrains indirectly to large OEM manufacturers of heavy-duty and medium-duty step vans, city delivery trucks, and utility trucks, rather than direct fleet sales.

Sample Competitor	Enova Systems
	Enova Systems designs and suppliers digital power components and drive system products for electric and hybrid electric buses and medium and heavy-duty commercial vehicles. Enova's core competencies are focused on the development and commercialization of power management and conversion systems for advanced transportation applications.
Location of Headquarters	Torrance, California
Number of Employees	30
Facilities	Enova leases a 43,000 square foot office and manufacturing facility at the Torrance headquarters.
Powertrain Products	• **Enova Systems All-Electric (BEV) and hybrid-electric drive** – Custom OEM powertrain designs intended for medium and heavy-duty trucks and buses (e.g. Smith Newton Electric Truck, Freightliner MT-EV electric step van). Enova drive trains support multiple power levels from 80kW to 240kW. • **Omni Series 200kVA Power Inverter** – A software configurable power inverter that is compatible with a wide range of vehicle sizes and multiple drive systems and motors. It can be configured for HEV, PHEV and EV applications. • **Omni Series 10kVA On-Board Charger** – a rugged liquid cooled, sealed charger for charging lithium-ion battery packs. It typically connects to standard charging stations (EVSE points)
Company History, Financing, and Revenue	Enova (previously known as US Electricar Inc.) was founded in 1976 and is a small early stage pre-cash flow firm. Enova has been funded through a combination of debt, lease financing and public equity offerings. It has a history of operating losses and negative cash flows from operations. Enova has stated that they will require substantial on-going capital investment to continue operations until economies of scale allow for reduced costs and higher volume sales. At December 31, 2011, Enova has an accumulated deficit of $151 million, and working capital of $6.8 million. As of December 31, 2011, the Company had approximately $3.1 million in cash and cash equivalents.
Ownership	Public: NYSE AMEX
Main Customers	Key customers which represent 94% of revenue include: • First Auto Works of China • Smith Electric Vehicles • Freightliner Custom Chassis Corporation • Navistar Corporation / International Trucks Other customers include Optare Bus, and Wrightbus
Business Model	Enova is essentially a design house that sells to OEM truck manufacturing partners rather than directly to fleet owners. Enova relies on a closely managed outsourced manufacturing strategy to control product costs while also minimizing fixed costs within the organization.
Sales and Distribution Strategies	Enova's product development strategy is to design and introduce to market successively advanced products, each based on Enova core technical competencies. Enova also believes in sharing technical requirements and common components among the market segments to allow them to transition quickly from one emerging market to the next, with the goal of capturing early market share.

3.2 Porter 5-Forces Analysis of the North American and European Commercial Electric Vehicle Market

This section considers the factors affecting the attractiveness of commercial electric vehicle market segments. Porter's Five Forces framework model(Porter & Millar, 1985) is used to understand the effects of the industry participants on the structure of the industry. The five forces that drive industry profitability using this model are illustrated in Figure 21.

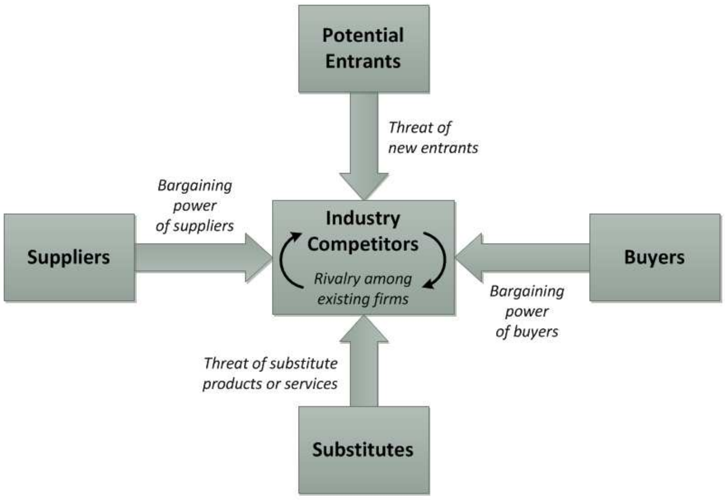


Figure 21 The Five Forces Model - Factors Driving Industry Profitability - Source: (Porter & Millar, 1985)

The relative strength of these factors for the light-duty commercial vehicle (LCV) and medium-duty commercial vehicle (MCV) segments are shown in Table 14.

Table 14 - Strength of Forces in LCV and MCV Segments

Force	Strength in LCV Segment		Strength in MCV Segment	
Threat of Buyer Power	3.2	Medium	3.5	Med-High
Threat of Rivalry	3.73	Med-High	3.55	Med-High
Threat of New Entrants	1.86	Low	2.14	Low
Threat of Substitutes	4.33	High	4.67	Very High
Threat of Supplier Power	3.44	Med-High	3.56	Med-High
Overall Average	**3.31**	**Medium-high**	**3.48**	**Med-High**

Scale: 1=Very Low, 2=Low, 3=Medium, 4=High, 5=Very High

These strengths for the five forces for each of the LCV and MCV market segments can be visualized more easily in the radar plots in Figure 22 and Figure 23.

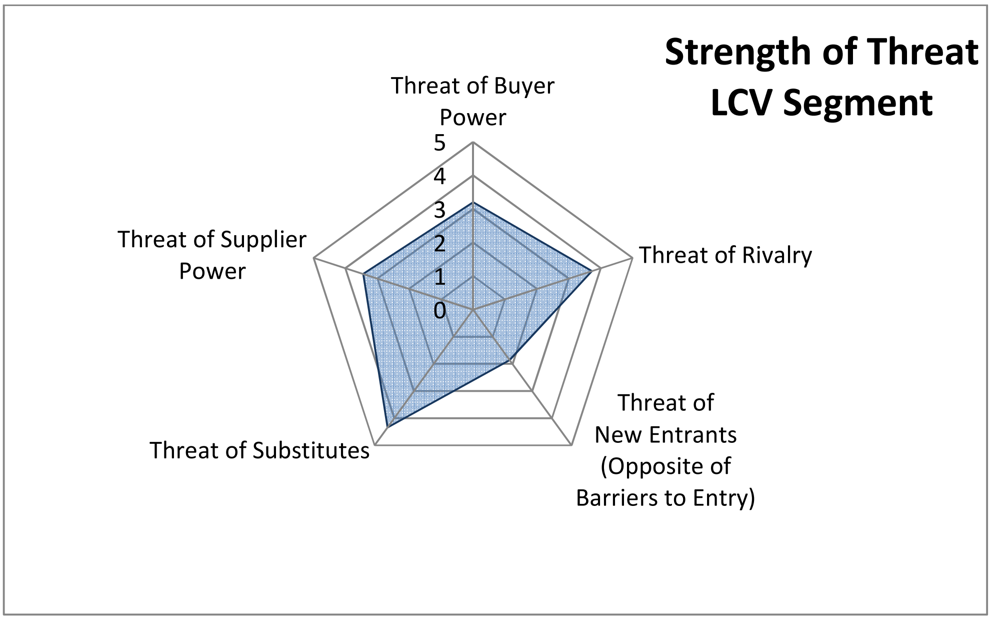


Figure 22 - Graph of Relative Strength of Threat - LCV Segment

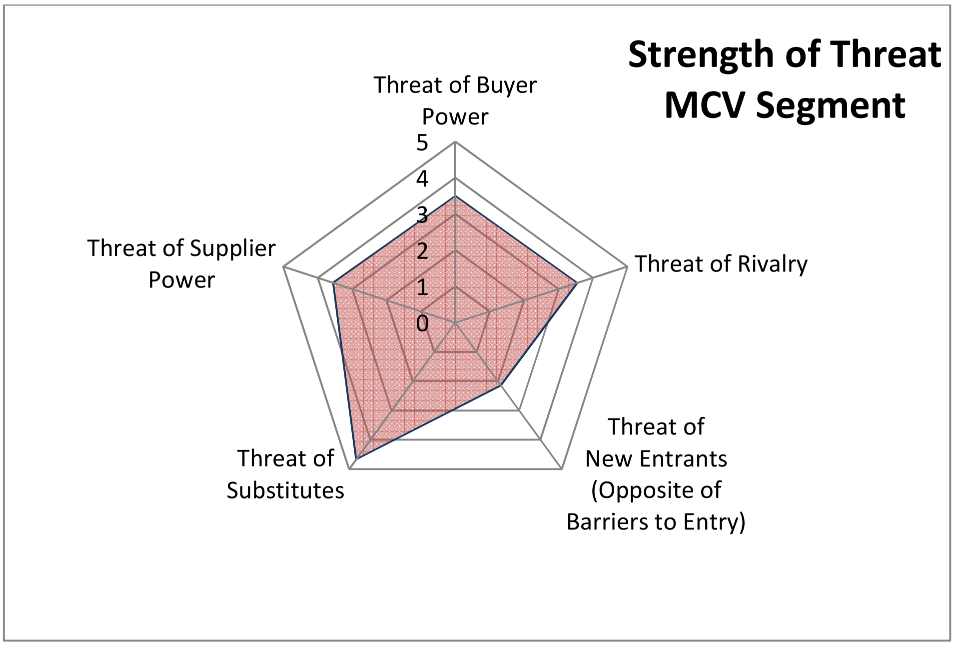


Figure 23 - Graph of Relative Strength of Threat - MCV Segment

These forces, which affect the LCV and MCV segments, are discussed in detail below.

3.2.1 Threat of New Entrants

The relative **Threat of New Entrants** to industry incumbents is the reverse of the strength of **Barriers to Entry** in the commercial electric vehicle industry. Low barriers to entry increase the likelihood that new firms would enter the sector, whereas high barriers to entry decrease this likelihood. The factors affecting Barriers to Entry are shown in Table 15. The strength of Barriers to Entry is then inverted to derive the Threat of New Entrants (so that this force is expressed as a threat to incumbents consistent with the other Porter forces).

Factors Affecting Barriers to Entry	Factor Strength LCV Segment	Factor Strength MCV Segment
Economies of Scale	4	4
Product Differentiation	4	2
Capital Requirements	4	3
Switching Costs	2	3
Access to Distribution Channels	3	4
Cost Disadvantages (Independent of Scale)	4	3
Government Policy	1	1
Barriers to Entry – Average	**3.14**	**2.86**
Threat of New Entrants (Reverse of Barriers to Entry)	**1.86**	**2.14**

Table 15 – Barriers to Entry and Threat of New Entrants by Segment (Scale of 1 to 5, 1=lowest, 5=highest)

When discussing Barriers to Entry in the industry faced by potential light-duty (LCV) and medium-duty (MCV) truck manufacturer entrants, it is important to consider the scope of the target market under consideration. The trucking industry can be segmented by powertrain technology (conventional versus hybrid-electric or all-electric), or segmented by the stage within the automotive supply chain for the target market (suppliers of powertrain component parts and sub-systems versus OEM suppliers for the entire truck or commercial vehicle).

There are significant differences between the barriers to entry for the truck manufacturing industry (when considered as a whole) versus using just trucks employing only electric powertrain technologies. Conventional truck powertrains have a dominant design based on internal combustion engine (ICE) technology (both gasoline and diesel), and there are only a few powerful incumbent OEM truck firms (e.g. Daimler, PACCAR, Ford, GM, Renault-Nissan) who have the power to exploit economies of scale, access to distribution channels and product differentiation based on brand identification. Barriers to entry are very high for entrants wanting to manufacture conventional powertrain trucks.

For trucks with electric powertrain technologies, the story is different. As of yet, there are no established dominant designs (although there are several competing technologies). Hence, barriers to entry are high (but lower than conventional powertrains). Even among HEV, PHEV and BEV electric powertrain technologies, there are differences in barriers to entry. Hybrid powertrain development costs are higher because of the complexity of designing optimal dual-mode engine and battery management schemes whereas all-electric powertrains are inherently simpler and cheaper to develop.

There have been numerous entrants over the last ten years in new niche areas for all-electric vehicles: neighbourhood electric vehicles (not subject to crash-test certification for top speeds < 40 km/h), electric motorcycles, and e-bicycles. In these new niche areas, the new entrants seek to minimize costs associated with full-speed passenger vehicles. However, the number of market entrants in LCV and HCV hybrid-electric and all-electric truck segments has been much lower than in these niche EV technology markets.

There are also considerable differences between barriers to entry faced by potential entrants in the final vehicle manufacturing stage (truck OEM manufacturers) versus potential entrants to Tier-1 and Tier-2 truck component and sub-system manufacturers. Small manufacturers can afford to develop small subsystems – e.g. vehicle powertrains. However, the cost of designing and manufacturing an entire commercial truck would be prohibitive for a smaller Tier-2 component supplier. Only large OEMs can typically afford to contemplate incurring the cost of integrating a truck chassis with numerous engine components and subsystems, and to undertake the testing costs to meet stringent vehicle safety, emissions and regulatory requirements. For example, Azure Dynamics chooses to design and manufacture just the powertrain subsystem, and partners with a major truck OEM manufacturer (Ford) to avoid the costs of designing the rest of the truck chassis and truck vehicle systems. Thus, there are more entrants to the automotive component stage of the industry (lower barriers to entry) and fewer new OEM entrants for the final commercial vehicle manufacturing stage (high barriers to entry).

For this section, we define the scope of the analysis for Barriers to Entry as the commercial vehicle (trucking) market employing only electric powertrain technologies, but at the final stage of the supply-chain (fully integrated commercial-electric vehicles rather than electric truck powertrain components).

The **Economies of Scale** factor in Barriers to Entry is high (4). Larger incumbent truck manufacturers have a cost advantage if they can spread their fixed costs over more vehicle models. This is a barrier to entry to new entrants with lower production volume and higher costs per vehicle.

The **Product Differentiation** barrier to entry factor is high (4) with the LCV segment and Low-Medium (2) in the MCV segment. Brand identification and customer loyalty with fleet customers is especially strong within the light-duty LCV segment where past advertising and customer service reputation is important. Brand identification and customer loyalty is not as strong in the MCV segment.

The **Capital Requirements** factor is very high (4) in the LCV segment and medium to high (3) in the MCV segment. The commercial truck manufacturing industry has very high R &D fixed costs to develop powertrain systems, and large amounts of effort are needed to create designs and IP. In addition to high R&D costs, new entrant firms have higher start-up capital requirements because they must extend credit to fleet customers, incur the costs of seeding fleets with demonstrator vehicles, and spend capital to build inventories of powertrain parts.

The **Switching Costs** factor is low (2) for the light-duty LCV fleet truck segment and moderate (3) for the medium-duty MCV fleet truck segment. It is relatively easy for customers to switch vendors to a new entrant since costs to alter specifications, retrain dealer staff, and adapt to a new commercial electric vehicle are relatively low. Switching costs potentially could be even lower but some dealers are "locked in" to a particular brand or manufacturer.

The **Access to Distribution Channels** factor is medium (3) in the LCV segment and high (4) in the MCV segment because there is unequal access to distribution channels. Unless a new firm has a strong strategic alliance with OEM truck manufacturers, it is difficult to acquire dealer channels for selling commercial electric vehicles to large fleets. There are only a limited number of partners or potential dealers available.

The **Cost Disadvantages** (Independent of scale) factor is medium to high because of the importance of product trade secrets, proprietary technology and the importance of the learning curve (or experience curve) in the industry. Incumbents have lower costs from the amount of accumulated time involved and the amount of intellectual property. These cost advantages are difficult to replicate by potential entrants no matter what is the attained scale of the entrant.

Government Policy factor is low (1) because there are readily available subsidies for purchasing hybrid-electric and battery electric vehicles for both incumbents and new entrants. In addition, the commercial truck market has a standard set of features, many of which are mandated by regulations and standards. Standardization reduces barriers to entry, since these standard features are well known.

Overall, the average of the **Barriers to Entry** factors is High (3.14 for the LCV segment and 2.86 for the MCV segment). These values are inverted to derive the **Threat of New Entrants** (to be consistent with the other Porter forces that are expressed as threats to incumbents). The **Threat of New Entrants** is Low (1.86 for the LCV segment and 2.14 for the MCV segment).

3.2.2 Threat of Rivalry (Existing Competitors)

The rivalry in the commercial truck industry for creating hybrid-electric and all-electric vehicles is very intense. The most important factors affecting Threat of Rivalry are Competitor Size, and Diversity of Competitors, which are mentioned in detail below.

The **Competitor Size** factor is 5 (very high), because some competitors have the size and the working capital to be able to sacrifice margins for gaining market share. An example of this is the "Green For Free" program offered by Freightliner Custom Chassis Corporation (FCCC). FCCC sells fleet operators all-electric trucks at the price of a conventional diesel truck and FCCC absorbs the up-front incremental cost of the vehicle. The fleet savings (from reduced maintenance and fuel savings) are used to offset the incremental expense for the technology. A competitor such as Daimler / Freightliner has the size and the financial resources to be able to afford a program like this to spur volume and increase market share at the expense of short-term margins.

The **Competitor Diversity** factor is 3 (moderately high) as there are numerous firms which have differing strategies and goals for how to compete, and these firms constantly run up against each other in the fleet procurement process. In the Class 1-2 light-duty (LCV) segment there are

7 notable competitors to Azure Dynamics who have developed or entered production with all-electric BEV delivery vans (Table 10). In the class 3-6 medium-duty (MCV) hybrid-electric and all-electric walk-in van segment, there are 5 firms competing with Azure Dynamics (Table 11). In the class 3-6 MCV hybrid-electric cargo van and shuttle bus segment (excluding walk-in step vans), there are 8 competitors to Azure Dynamics (Table 12).

Overall, the **Threat of Rivalry** is High (3.55) for both the light-duty LCV and medium-duty MCV segments (Table 16).

Drivers of Degree of Rivalry	Driver Strength LCV Segment	Driver Strength MCV Segment
Competitor Size	5	5
Competitor Diversity	3	3
Exit Barriers	5	5
Ease of Expansion	3	2
Storage Costs	3	3
Undifferentiated Product	2	3
Zero Sum Game	5	5
Average	**3.55**	**3.55**

Table 16 - Threat of Rivalry Among Existing Competitors by Segment

3.2.3 Threat of Substitutes

The development of commercial natural gas vehicles (NGV) using either liquefied or compressed natural gas (LNG or CNG) poses a real substitute threat to the markets for hybrid HEV trucks and all-electric BEV trucks. This threat is strongest in the medium-duty (MCV) and heavy-duty (HCV) trucking sectors. Natural gas is not as much of a threat in the light-duty LCV segment of the truck market as well as in applications where governments mandate a zero-emission all-electric EV solution. For example, forklifts by law now must be electric when used indoors. In addition, US publically funded airports now have an incentive from US federal grant money to convert their Ground Support Equipment (GSE) to all-electric BEV vehicles.

Favourable market conditions are promoting the adoption of natural gas vehicles (NGV) which is driven by the relatively cheap and stable prices for natural gas. The rising demand for global oil reserves is driving gasoline and diesel prices higher, and the motivation to switch to cheaper CNG or LNG fuel intensifies.

The HCV heavy-duty truck segment includes long-haul Class 8 trucks and vocational trucks (e.g. utility trucks, cement mixers, and refuse trucks). These vehicles have large engine displacements that consume vast amounts of fuel. There are significant cost advantages for natural gas use particularly LNG) in HCV markets. PACCAR/Peterbilt, Freightliner and McNeilus all provide heavy-duty trucks that use diesel engines converted to natural gas using technology from companies such as Westport Innovations.

MCV medium-duty NGV trucks are just starting to appear on the market as CNG refuelling stations and infrastructure are expected to become more common (especially along US Interstate highway grid corridors). The adoption of NGVs will also be accelerated by the recent availability of new combination dual-fuel (diesel + CNG) truck engines.

CNG is a lesser threat to light-duty trucks because CNG has a low energy density and the tanks take up a lot of space. For instance, NGV taxi conversions have very little trunk space due to the size of CNG tanks. The fuel tanks are also heavy since CNG has a low specific energy. A very strong tank is required to keep the fuel safe in a vehicle crash.

Overall, the **Threat of Substitutes** (4.33 for LCVs and 4.67 for MCVs) is very high (Table 17).

Factors Affecting Threat of Substitutes	Factor Strength LCV Segment	Factor Strength MCV Segment
Availability of Beneficial Alternative	4	4
Availability of Cheap Alternative	4	5
Switching Costs (1=high, 5=low)	5	5
Average	**4.33**	**4.67**

Table 17 - Threat of Substitutes by Segment

3.2.4 Threat of Buyer Power

Many customers in commercial truck markets are firms or leasing companies with large fleets. These fleet buyers have the advantage and the motivation to drive down truck prices by playing truck suppliers off against each other. While small-to-medium businesses (SMBs) typically purchase through dealers, large fleet owners frequently will buy direct from the vehicle OEM supplier. Unlike dealer customer who are typically franchises locked in to one particular OEM truck manufacturer, large fleet buyers are independent and thus the **Buyer Independence** driver is 4 (high). Fleet buyers are often much bigger than start-up EV firms and thus the **Buyer Size** and **Financial Muscle** factors are also 4 or high. As a significant portion of fleet operating costs are fuel (> 50%), fleets are particularly sensitive to fuel costs (**Price Sensitivity** is moderate to high) and thus fleet operators will shop around.

Overall, the **Threat of Buyer Power** (Bargaining Power of Customers) is moderately high (3.2 for LCV and 3.5 for MCV segments) (Table 18).

Drivers of Buyer Power	Driver Strength LCV Segment	Driver Strength MCV Segment
Backwards Integration	1	2
Buyer Independence	4	5
Buyer Size	4	4
Financial Muscle	4	4
Oligopsony Threat	3	4
Price Sensitivity	4	3
Product Dispensability	4	4
Tendency to Switch	2	3
Undifferentiated Product	2	3
Average	**3.2**	**3.5**

Table 18 - Threat of Buyer Power by Segment

3.2.5 Threat of Supplier Power

The three most important components of the **Threat of Supplier Power** in the truck manufacturing industry are **Switching Costs**, **Player Dispensability**, and **Differentiated Input**. **Switching Costs** are 4 (high) since it is not easy for EV manufacturers to switch battery suppliers (the powertrain design is tightly coupled to the particular battery characteristics and communications interface). **Player dispensability** is high since many battery suppliers are diversified into other industry segments apart from truck applications. **Differentiated Input** is high since many of the input components have unique capabilities or benefits. Overall, the **Threat of Supplier Power** is Moderately High (3.44 for LCV segment and 3.56 for the MCV segment) (Table 19).

Drivers of Supplier Power	Driver Strength LCV Segment	Driver Strength MCV Segment
Switching Costs	4	4
Player Dispensability	5	5
Differentiated Input	5	5
Forward Integration	1	1
Importance of Quality / Cost	3	3
Substitute inputs	3	3
Oligopoly Threat	3	3
Player Independence	4	5
Supplier Size	3	3
Average	**3.44**	**3.56**

Table 19 – Threat of Supplier Power by Segment

3.3 Attractiveness of Industry and Key Success Factors

In 2010 and 2011, the market for conventionally powered commercial vehicles has rebounded since the economic downturn in 2009 when most auto manufacturers struggled to cope with financial pressures, and major giants such as Chrysler and GM ended up filing for bankruptcy protection while government bailouts assisted in their restructuring.

Overall, the average of all five forces or threats to incumbents in the truck industry is Medium to High (3.31 in the LCV fleet truck segment and 3.48 in the MCV fleet segment). In particular, this is largely due to an intense Threat of Internal Rivalry for HEVs and EVs in the consumer automotive and truck sectors. Starting in 2005, Government subsidies and considerable industry hype also contributed to the emergence of a great number of entrants in a competitive HEV and EV marketplace. Early stage firms such as Azure Dynamics, Think Technologies, Bright Automotive, Smith Electric Vehicles, Boulder Electric Vehicles, Electric Vehicles International, Modec, Enova Systems, and ZeroTruck joined the industry alongside larger more-established OEM incumbent truck manufacturers such as Daimler, Renault, Iveco, DAF, Volvo/Mack Trucks, International, Hino, Isuzu, Mitsubishi Fuso, and PACCAR (Kenworth / Peterbilt).

Despite the rivalry, the greatest threat to the growth of the commercial hybrid-electric and electric vehicle industry is the Threat of Substitutes. The viability of vehicle electrification is jeopardized by on-going improvements in the efficiency and range of trucks using conventional internal combustion engine (ICE) powertrains.

For instance, Isuzu, in partnership with Utilimaster, recently introduced the Isuzu Reach medium-duty truck. The Reach is a Class 4 walk-in van or “step van” typically used for parcel delivery. Using lightweight composite materials in the body panels to reduce weight by over 400 kg and employing a more efficient diesel-powered engine has enabled Isuzu to create a vehicle with fuel consumption figures that rival the Azure Dynamics Balance series of hybrid-electric gas powered walk-in vans, but without the added cost of electrification. There is also a grave threat to the medium and heavy-duty segments from substitute diesel powertrains that have been converted to CNG or LNG. The relative abundance of natural gas has kept prices exceedingly low - less than $1.70 GGE (gasoline gallon equivalent). The potential harvesting of vast unconventional shale gas deposits using fracking technology has increased the lifetime of known natural gas reserves to over 200 years.

Since 2011, there has been a string of companies (including many of the aforementioned entrants in the HEV and EV marketplace) who have shut down or ceased operations:

- **Modec** - Following a decline in sales, Modec entered administration (bankruptcy proceedings in the UK) in March 2011. Navistar International purchased all of remaining assets and intellectual property.

- **Think Global** – In June 2011, Norwegian EV vehicle manufacturer Think Global AS filed for bankruptcy after recapitalization and restructuring efforts failed.

- **Bright Automotive** - Bright was a start-up Indiana company developing a PHEV light-duty van called the IDEA. Bright targeted the IDEA specifically at large fleet customers in the LCV segment. On February 28th, 2012, Think filed for bankruptcy when the company failed to receive a federal retooling loan.

- **Aptera** – On December 2, 2011, Aptera Motors announced it was going out of business. Aptera cited that they were unable to raise private financing to match a conditional $150 million US federal loan to continue development of their electric cars. Aptera was founded in 2006 and was best known for the creation of the Aptera 2e, an aerodynamic three-wheeled prototype.

- **Azure Dynamics –** In late March 2012, Azure went into CCAA proceedings (Canadian bankruptcy protection law which is similar to Chapter 11 in the USA) after failing to secure new investment capital or low-interest loans.

As a result, this report concludes that the **commercial electric vehicle industry level of attractiveness** is **Low for the short-term** (in the next 5 years) and **Moderate to Good in the longer term**. The economic climate is very challenging for both the automotive and truck sectors. The crisis of confidence and malaise in the industry has occurred for a number of reasons:

1. Despite a flood of attention given to EVs recently because of the ramp-up in world oil prices in 2011, the adoption of hybrids, plug-ins and pure battery-electric vehicles has been running significantly more slowly than proponents have anticipated. For instance,

GM had hoped to sell 60,000 Volts worldwide, but adjusted that forecast ahead of the January 2012 North American International Auto Show in Detroit. In 2011, Last year, GM missed its goal of selling 10,000 Volt vehicles, selling just over 7,500 vehicles.

2. The extremely high initial capital outlay for commercial xEV trucks has become a major impediment to fleet sales (primarily due to the impact of lithium-ion battery costs). The payback period for recovering the incremental cost of a light-duty BEV truck is still in the 9 to 11 year range.

3. In 2011, a highly publicized failure of lithium battery packs occurred when Consumer Reports started testing the Fisker Karma plug-in hybrid car. As a result, battery maker A123 Systems announced a $55 Million recall of defective lithium-ion batteries supplied to all five of their OEM vehicle customers.

4. The brand reputation of the Chevrolet Volt was harmed by several battery fires. The first incident occurred at NHTSA in June 2011 during crash safety testing. Another couple of thermal failures occurred in November 2011 during further testing of the Volt's batteries. After a thorough investigation, in January 2012 NHTSA later announced that improper testing procedures (e.g. failure to properly shutdown and de-energize battery packs) were a root cause of many of the problems.

5. Tesla Motors, a key start-up participant in the electric sports car market revealed that some owners' electric sports cars experienced catastrophic battery failures known as "bricking."

6. There is considerable over-capacity in the lithium-ion battery manufacturing supply due to weak demand from customers of electric and hybrid-electric vehicles. Ener1, the parent company of US battery manufacturer EnerDel filed for bankruptcy protection. EnerDel built a plant for electric-vehicle component and lithium-ion battery manufacturing in Indiana that was partially funded by an American Recovery and Reinvestment Act (ARRA) grant of $118 million. Ener1 was heavily dependent on Think as a major customer and ran into problems with the insolvency of Think.

Nine companies (see Table 20) received grants to build advanced-battery factories from the US government as part of the ARRA in 2009.

Applicant	DOE Award	Manufacturing Facilities	Technology
Johnson Controls, Inc.	$299.2 M	Holland, MI Lebanon, OR	Manufacturing of battery cells and packs for hybrid and electric vehicles.
A123 Systems, Inc.	$249.1 M	Romulus, MI Brownstown, MI	Manufacturing of battery cells and pack for hybrid and electric vehicles.
Dow Kokam	$161 M	Midland, MI	Production of lithium-ion batteries for hybrid and electric vehicles.
LG Chem / Compact Power	$151.4 M	St. Clair, MI Pontiac, MI Holland, MI	Production of lithium-ion polymer battery cells for the GM Volt
EnerDel, Inc.	$118.5 M	Indianapolis, IN	Production of lithium-ion cells and packs for hybrid and electric vehicles.
General Motors	$105.9 M	Brownstown, MI	Production of high-volume battery packs for the GM Volt
Saft America, Inc.	$95.5 M	Jacksonville, FL	Production of lithium-ion cells, modules, and battery packs for industrial and agricultural vehicles and defense application markets.
Exide Technologies	$34.3 M	Bristol, TN Columbus, GA	Production of advanced lead-acid batteries, using lead-carbon electrodes for micro and mild hybrid applications.
East Penn Manufacturing	$32.5 M	Lyon Station, PA	Production of a combination lead-acid battery and carbon super-capacitor for micro and mild hybrid applications.

Table 20 - ARRA Recovery Act Awards for EV Battery and Component Manufacturing

3.3.1 Key Success Factors

For now, the supply of electric- and hybrid-vehicle batteries considerably exceeds the demand. Until economies of scale reduce Li-Ion battery prices and raise demand, for now North American xEV manufacturers will have to adopt appropriate survival strategies. Key success factors for surviving in this economic climate are:

1. **Find an investor with extensive financial resources and committed for the long run.** The manufacturer needs to find a large firm to purchase or invest in their firm, or else take a significantly large equity stake in the firm. One common approach is for a candidate firm to trade access to their intellectual property and manufacturing rights in exchange for an equity investment. Selection of a buyer with significant financial resources is critical as only well-funded EV manufacturers companies are going to survive for at least 3 years or so. It will likely take at least this amount of time for battery prices to become more economical.

2. **Choose a Niche Segmentation Strategy.** The xEV manufacturer can choose one of Porter's Generic Strategies: a Segmentation Strategy to narrow the market scope to an area that is less price-sensitive and more willing to pay extra to benefit from the advantages of zero emission vehicles (ZEVs) for their fleet. An example of this is a firm called Balqon Corporate who produces electric powertrains for Class 7-8 heavy-duty HCV trucks. Balqon chooses to avoid selling their electric trucks to the majority heavy-duty fleet customer, but rather to a specifically targeted subset – namely to container terminal fleet logistics customers (e.g. Port of Los Angeles). Here, the customer has a specific requirement for zero emissions, and is willing to pay a premium price to select vehicles that possess the right attributes.

3. **Mitigate the Battery Pricing Issue**. If battery prices are the main issue with competing with a cost leadership strategy, then an EV manufacturer firm needs to find a way to mitigate the high battery prices – to take them out of the equation. Companies like the Nissan/Renault partnership have adopted a new business model by unbundling the expensive battery pack component from the overall vehicle price. Nissan/Renault partners with an innovative American/Israeli battery development firm called Better Place who provides a battery-leasing program for vehicle customers. For a flat monthly fee (approximately $75 per month), Better Place provides customers with a way to exchange EV batteries at a charging depot or station. When battery packs are depleted, they can be swapped out for a fully charged battery pack.

4. **Focus on Key Contracts with Large Fleets**. Many early adopter sales are small batches sold to smaller fleets - often municipalities or government agencies. A key success factor is focusing on national accounts with large fleets. This approach avoids the trap of devoting precious direct sales resources to sell to customers wanting only a couple of fleet demonstrator vehicles. This type of customer usually wants to promote an eco-friendly public image (sometimes referred to in the industry as "green-washing"). A small EV manufacturer needs their direct sales staff to focus entirely on volume orders with large fleets. Smaller purchases can be offloaded to fleet dealers through partnerships (e.g. Azure takes advantage of the Ford dealer distribution network to make sales to smaller fleets to free up the time of their regional sales staff).

Consider the case of Smith Electric Vehicles. In late 2010, Smith Electric Vehicles based in UK and owned by the Tanfield Group, also in the UK, was struggling financially and faced potential insolvency. Tanfield sold their rights to Smith Electric Vehicles USA – the American arm of the firm. In late 2011, Smith Electric Vehicles USA was also experiencing cash flow difficulties. However, in early 2012, Smith Electric Vehicles secured $20 million direct equity funding in 2012, along with $75 million capital to establish a joint venture in China with the Wanxiang Group – a large Chinese auto parts giant. The Smith Electric partnership deal with the Wanxiang Group has considerably improved Smith long-term chances of survival (even though they are not out of the water yet).

The potential of the EV industry is attractive in the long run, but only for firms with a persistent and steadfast commitment. In order for Azure Dynamics to survive in this climate, it requires a sustainable business model, and the backing of a parent enterprise with considerable financial influence and a long-term vision of the industry.

INTERNAL ANALYSIS

4 Value Chain and Core Competency Analysis of Azure Dynamics

This chapter examines the core capabilities of Azure Dynamics both pre-insolvency and post-insolvency with the objective of determining the firm's sources of competitive advantage. A resource-based view of the firm is used as a lens to assess Azure Dynamics capabilities. The resource-based view asserts that the superior industry performance and basis for competitive advantage of a firm (the ability of a firm to extract or derive economic rents) arises from the application of a bundle of resources which are Valuable, Rare, Inimitable, and exploitable by an Organization (Barney, 1991, Wernerfelt, 1984)

At a macro level, this analysis of Azure Dynamics follows the overall appraisal approach of Robert Grant as shown in Figure 24.

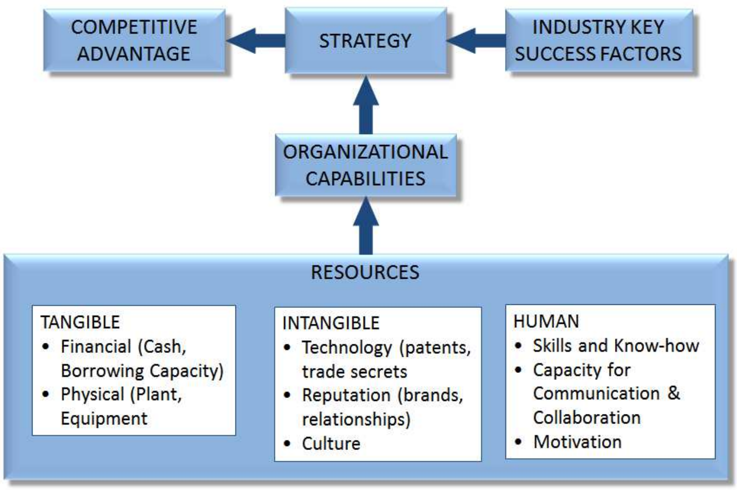


Figure 24 - Links Between Resources, Capabilities and Competitive Advantage - Source:(Grant, 2008)

Grant's approach to analysing a firm's competitive advantage begins with an inventory of firm resources and capabilities (Grant, 2008). This chapter uses Michael Porter's Value Chain framework (Porter, 1998b) to identify the primary activities related to the flow of goods within Azure Dynamics, and the secondary activities needed to support the flow. A map of primary and support activities at Azure is shown in Figure 25. The legend uses colour highlighting to identify outsourced activities and core activities performed in-house. For each stage, the analysis examines whether the Azure performs the activity in-house, or outsources or contracts it out to strategic partners or subcontractors. The analysis also considers how the resources and capabilities associated with each activity add value to Azure's business or provide competitive advantage through a Cost Leadership strategy, Differentiation strategy, or Focus strategy.

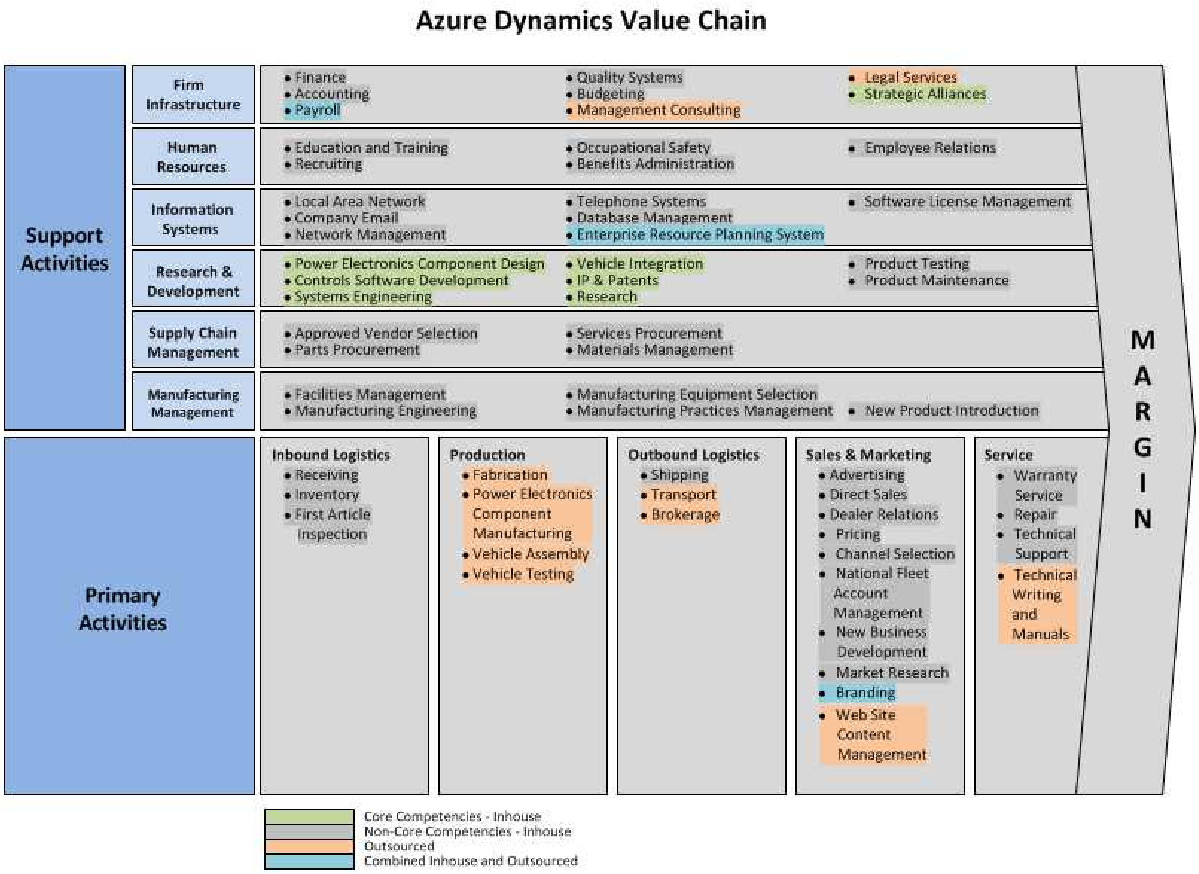


Figure 25 - Azure Dynamics Value Chain – Source: (Porter, 1998b)

4.1 Value Chain - Primary Activities

Azure Dynamics designs and markets its powertrain products, but is not involved in production or assembly. Azure outsources the majority of its manufacturing activity to recognized industry component manufacturers and upfitter partners like Utilimaster Corporation and AM General LLC to integrate its HEV, PHEV and BEV solutions onto existing OEM vehicle platforms.

Figure 26 and Figure 27 illustrate this manufacturing strategy by showing Azure's supply chain and distribution networks for both the Balance Hybrid-Electric and Transit Connect Electric product lines respectively. These supply chain diagrams are an application of a generic model of the industry value chain as described in section 2.9.

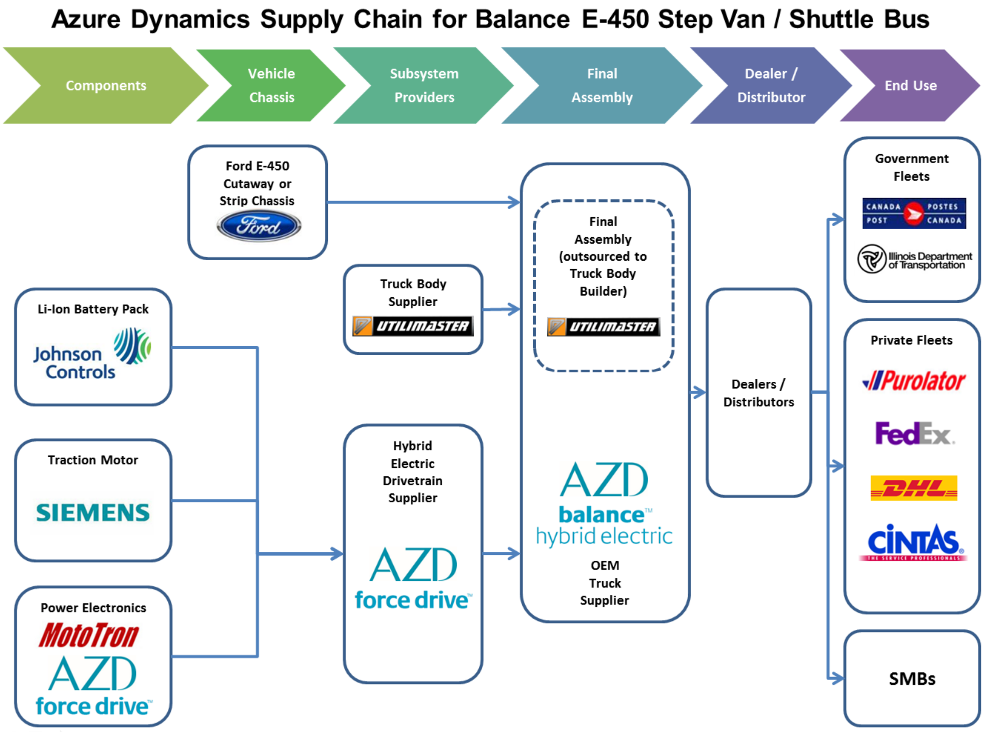


Figure 26 - Azure Dynamics Supply Chain - Balance Hybrid-Electric Product Line

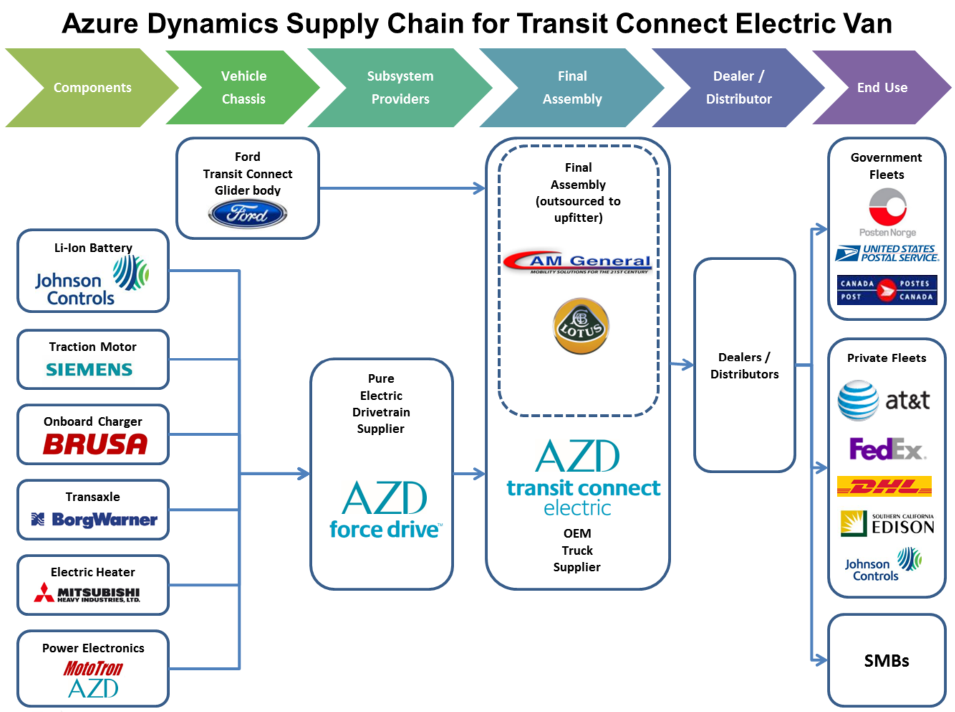


Figure 27 - Azure Dynamics Supply Chain - Transit Connect Electric Product Line

Fleet operators are accustomed to purchasing vehicles from upfitters and body builders because each operator typically already needs their vehicles to be adapted for specific applications. Azure's engineering team has a very limited capability in-house to perform assembly for a small number of prototype or field trial vehicles (e.g. less than 10 to 15 units). This capability is extremely labour-intensive and is not intended to be scaled to volume production.

This outsourced manufacturing approach allows Azure to limit the level of investment in tooling, fixed assets, and expansion costs. The approach is intended to allow Azure to scale its capacity more rapidly without the risks associated with significant capital investment. When compared to most other powertrain suppliers in the commercial automotive industry, Azure's investments in fixed assets are relatively low.

An important part of the strategy to outsource manufacturing is securing sources of high-quality automotive components. Azure takes advantage of a comprehensive list of supply chain partners to deliver powertrain systems to its fleet customers. Azure collaborates closely with recognized automotive suppliers including electric motor manufacturers, battery suppliers, OEM truck chassis manufacturers, automotive parts suppliers, and truck dealerships. Azure engineers work closely with suppliers' product development support teams. Azure also uses the existing distribution network of Ford as an alliance partner to gain access to the market for trucks.

Azure Dynamics designs components for reusability so that they can be deployed in multiple vehicle platforms as much as possible. Azure engineers strive to minimize any dependencies for the design of key components on any particular vehicle architecture.

4.1.1 Inbound Logistics

The logistics function at Azure is primarily used to support receiving and shipping of prototype components, parts and assemblies that are used during engineering design, vehicle integration, vehicle testing and validation for pre-production prototype vehicles. Logistics and inventory management for final vehicle assembly and production are handled directly by the outsourced upfitter (e.g. Utilimaster for the Balance hybrid-electric truck, and both AM General and Lotus Lightweight Structures for the TCE electric van).

During the prototyping and pre-production, Azure's supply chain purchasing team works closely with engineering and is involved in vendor selection and parts procurement. The engineering development team prepares a bill of materials (BOM) list of component parts and sub-assemblies for each prototype vehicle. A small inventory of prototype parts are received and stored at Azure. The quality control team performs "first article inspection" to make sure that production-intent parts meet proper dimensions and tolerances, and to make sure that the quantities and part numbers are correct. Prototype vehicles and field trial vehicles are assembled in-house at Azure and are sent to various testing facilities for validation.

When field trials are complete and the vehicle is ready for mass production, a final production bill of materials (BOM) is sent to the upfitter. The upfitter then has the responsibility to receive, store, inspect, handle and control the inventory of parts. Although the inventory of parts belongs to Azure Dynamics, it is drop-shipped directly to the upfitter.

4.1.2 Manufacturing and Production

As mentioned at the beginning of the 4.1 Primary Activities section, Azure also chooses to outsource manufacturing by collaborating with truck up-fitters who assemble products to Azure specifications, rather than manufacturing components and assembling powertrain systems in-house. Azure uses three upfitters according to product line requirements and geographical scope. This upfitters include:

- **AM General LLC (AMG)** – assembles the Transit Connect Electric (TCE) van in Livonia, Michigan, USA for the North American market.
- **Utilimaster Corporation** - assembles the Balance Hybrid Electric vehicles out of the Utilimaster facility in Wakarusa, Indiana, USA
- **Lotus Lightweight Structures Ltd** - assembles the Transit Connect Electric (TEC) van at the Lotus plant in Worcester, England for the European market.

4.1.3 Outbound Logistics

Orders are passed on by Azure's sales team to Azure's operations team which will pass the order onto the truck upfitter (e.g. Utilimaster, AMG or Lotus). The upfitter configures and packages the vehicles according to the purchase order specifications. Final vehicle assemblies are shipped to fleet customers and dealers directly from the upfitter's production line.

4.1.4 Sales & Marketing

Azure's customers represent the top commercial fleet operators in the world. They include Purolator Courier Ltd, Schwan's, CINTAS, FedEx Corporation, DHL, AT&T Inc., Johnson Controls, and Posten Norge (Norway Post). Table 21 lists Azure's top 10 fleet customers.

Azure Dynamics - Top Ten Customers

Customer Name	Total Vehicles(1)	Approximate Fleet Size
Purolator	955	4,000
Schwan's	323	6,000
Bus manufacturers	206	65,000(2)
Røhne Selmer (Norway Ford Dealer)	138	N/A
CINTAS	100	4,000
FedEx	82	36,700
DHL	80	18,500
AT&T	25	66,800
Johnson Controls	21	7,200
Norway Post	20	3,500
Top 10 Customers	**1950**	
Other Customers	303	
Total Units(1)	**2253**	

(1) Total vehicles delivered since 2008, plus backlog as of 2011-11-14

(2) Represents annual US para-transit vehicles in operation

(3) Auxiliary electric power units

Table 21 - Azure Dynamics Top Ten Customers, Source: AZD Investor Presentation 3Q2011

Current annual sales for conventional internal combustion engine (ICE) light-duty commercial vehicles (LCV) and medium-duty commercial vehicles (MCV) in North America and Europe are approximately 300.000 and 250.000 vehicles per year, respectively. Rising fuel prices, increasing fuel economy standards, more stringent emissions standards and environmental policies to promote energy independence are altering the transportation landscape, including the purchasing behaviour of commercial fleet owners and operators. Azure Dynamics product lines are positioned to take advantage of this growing market.

Azure Dynamics uses channel partnerships as its major method of distribution. As a result of its established relationship with Ford, Azure Dynamics is able (through higher volume) to share joint marketing and promotion with Ford, and has access through direct relationships with select Ford dealers worldwide to support sales and service. Smaller fleet customers can order the Azure Balance Hybrid vans and the Ford Transit Connect Electric vans through selected Ford dealers. For larger orders, large fleet customers can deal directly with Azure Dynamics national fleet sales account representatives.

The intent of Azure's sales and marketing strategy is to minimize the size of the internal sales force. In-house sales activities are limited to national account management, technical support, and Ford dealer/distributor sales force training.

4.1.5 Service and Support

Azure's manufacturing, engineering, and quality management processes have been audited and certified by Ford, and Azure is a Ford Quality Vehicle Modifier, resulting in Ford providing base vehicle warranty coverage for components not replaced or modified by Azure. Furthermore, all warranty repairs on Azure's components can be handled through Ford's warranty repair centres licensed by Azure. Azure Dynamics is the manufacturer of record for these vehicles, and holds the primary responsibility for customer support, warranty and service agreements.

4.2 Value Chain - Secondary Activities

4.2.1 Physical Resources and Facilities

Burnaby, British Columbia, Canada Office - Azure Canada operates a 20,000 sq. ft. mixed-use facility (see Figure 28) which is the financial and research & development headquarters. In addition to several vehicle service bays and hoists, this facility has a sophisticated dynamometer used for vehicle testing. Post-insolvency, the Burnaby office is the only facility remaining open.

Figure 28 - Azure Dynamics Burnaby Office

Oak Park, Michigan (near Detroit) - Azure US used a 36,000 sq. ft. mixed-use facility (see Figure 29) for corporate headquarters and management offices, as well as sales, supply chain administration and product support. This office was closed post-insolvency.

Figure 29 - Azure Dynamics Oak Park, MI facility

Woburn, Massachusetts (near Boston) - Azure USA used a 77,000 sq. ft. facility (see Figure 30) for component development. In addition, there was limited amount of component assembly, inventory storage located at the Woburn site. This office was closed post-insolvency.

Figure 30 - Azure Dynamics Woburn, MA office and plant

Stevenage, UK - Azure UK occupied a 4,000 sq. ft. mixed-use facility (see Figure 31) which was used as a home base for European sales and some light manufacturing support. This office was closed post-insolvency.

Figure 31 - Azure Dynamics Stevenage, England sales/support office

4.2.2 Financial Services

Azure's finance department in Burnaby is responsible for managing all of Azure's finances for all subsidiary companies in the Azure group including Azure Canada, Azure USA, and Azure United Kingdom, as well as managing intercompany transactions for the parent company Azure Dynamics Corporation. The primary responsibility of the department involves oversight of accounting activities (budgeting and planning, general ledger transactions, accounts payable, accounts receivable), preparation of tax and government reports, and managing the disclosure process as a public company including submission of financial statements to SEDAR. Other functions include managing the employee stock option program, oversight of outsourced payroll activities, and investor relations. Reporting activities include preparation of operating records and standard financial statements.

As a public company, Azure's financial reports are audited by Price Waterhouse Coopers (PWC) and conform to International Financial Reporting Standards (IFRS) rules that came into effect January 1st, 2011 to replace the older Canadian Generally Accepted Accounting Principles (GAAP) rules.

4.2.3 Legal Services

Azure outsources all legal activities to consulting legal counsel at a corporate law firm. These legal consultants are responsible for reviewing, interpreting and drafting purchasing and supply contracts, sales and licensing agreements (e.g. Non-disclosure or NDA agreements), employee contracts, etc. The legal consultants are also involved in all legal matters relating to the registration of Azure Dynamics as a public firm.

4.2.4 Strategic Alliances and Business Development

Azure's ability to form relationships with key supply chain partners is cited as an important part of Azure's "Best Partners" strategy (as mentioned in the Introduction in section 1.1.1) and is a core competence. Azure management seeks to form alliances with recognized automotive industry suppliers to reach its objectives. Azure looks specifically for:

- Partners who have a similar commitment to deliver eco-friendly solutions
- Partners who are aligned and committed to the right target markets

- Partners who are global minded
- Partners who are interested in co-branding support

4.2.5 Strategic Relationships

The key partnerships and alliances are:

- **Ford Motor Company** – Azure Dynamics is currently authorized to provide BEV, PHEV and HEV vehicle solutions for Ford's market leading light- and medium-duty commercial vehicles. Azure Dynamics relationship with Ford is critical to Azure's existence as a going concern. Azure's only current commercialized product lines are based on Ford vehicles. Ford's role is to act as the OEM supplier of truck chassis. Ford also provides access to their extensive dealer service network. The relationship with Ford is discussed in more detail in section 4.2.6.

- **Johnson Controls (JCI)** – JCI is the preferred supplier of lithium ion batteries to Azure Dynamics. Johnson Controls Inc. (Milwaukee, Wisconsin) supplies the batteries necessary to operate Azure's electric and hybrid electric technologies. Battery packs represent a significant cost in a typical system. JCI batteries are single source and specifically designed to meet the requirements of Azure Dynamics' drive systems.
- **AM General LLC** (Michigan) – AMG is an upfitter that provides Azure with outsourced production services for Transit Connect Electric vehicles for North America.
- **Utilimaster Corporation** – Utilimaster is an upfitter and truck body builder. Utilimaster supplies outsourced production services for the Balance Hybrid Electric delivery van.
- **Lotus Lightweight Structures Limited (UK)** – Lotus provides Azure with outsourced production services for Transit Connect Electric vehicles for Europe.

4.2.6 Key Strategic Relationship with Ford

In 2007, Azure signed a supply agreement with Ford for Azure's Balance medium duty hybrid-electric van. Ford provides Azure with strip chassis and cut-away E-series truck chassis for E-350 and E-450 medium duty trucks. Azure "electrifies" the vehicle chassis by providing Force Drive™ hybrid-electric powertrain components, which are installed at a third-party body-builder plant (or "upfitter"). The body-builder provides integration of the truck chassis with a delivery van body (for strip chassis configurations) or shuttle bus body (for cutaway chassis configurations).

Azure signed another agreement in 2010 with Ford for Azure's Transit Connect Electric light duty all-electric van project. Ford supplies the electric product group at Azure with a "glider" configuration (where the engine and its associated fuel and exhaust systems are absent) for the Transit Connect van. Azure then integrates its Force Drive™ powertrain and a Johnson Controls battery pack and sells the completed Transit Connect Electric vans back through the Ford Dealer network (which also provide fleets with after-sales warranty service and support.

Finally, in 2011 Azure concluded a third arrangement with Ford to design and supply a PHEV powertrain for the SuperDuty F-450 and F-550 truck family, to be delivered in 2013. Ford's F-Series Super-Duty product line holds more than a 50% share of the truck market for models equipped with conventional ICE engine power. According to Ford, it is the largest and most established cab and chassis brand in North America. This product will be targeted for medium-duty Class 5-6 bucket trucks targeted at electric and telecom utility fleet customers. These applications require a large battery pack (larger than a typical lithium-ion battery pack used in an ordinary hybrid-electric powertrain) to provide auxiliary power (e.g. for electrically powered hydraulic boom).

4.2.7 Quality Systems

Azure's comprehensive quality management system is certified to ISO9001:2008 and developed in compliance with TS16949 standards. Advanced Product Quality Planning (APQP) working principles and tools are used to establish and control the manufacturing process and product quality in conjunction with a phase-gate process for product development.

Azure's quality department is responsible for creating and communicating a vision for delivering quality products, and helping the rest of the organization with the integration of ISO 9000:2008 quality-related activities into their daily operations. Specifically, the quality team approves and maintains all documentation for engineering and production including standard operating procedures, inspection/test instructions and measurement systems designed to adequately monitor and measure product conformance, as well as the repeatability and reliability of the processes. Lean Manufacturing and Six Sigma concepts drive variation reduction and waste elimination using "SMART" data driven metrics as key performance indicators. All operators and technicians are trained for their specific job(s) and tested for competency verification on a regularly basis. Standard procedures mandate proper material handling and control of nonconforming product throughout the entire process. Proper storage, preservation, packaging and delivery methods are also planned, verified and executed to support production launch.

The Quality department also works with the engineering team to ensure that quality processes include design controls for quality. Customer requirements and expectations are the first inputs to the development process followed by Design Failure Mode and Effects Analysis (DFMEA). Drawings and specifications are generated and released under a strict change control system. Design Validation testing is developed based on the DFMEA and the customer's requirements and/or intended functional application. Cross-functional design Reviews are held throughout the product development process and are considered a critical deliverable for gate sign-off. The DFMEA, Design Reviews and Design Validation Testing support the design and development of the manufacturing process. Process Flow Diagrams, Process Failure Mode and Effects Analysis (PFMEA) and Process Controls Plans are initiated early in the Prototype Phase and provide valuable feedback for design for manufacturability, as well as ensure all critical aspects of manufacturing and quality are properly addressed at every stage of product development (as verified by production trial runs and process capability studies). The PFMEA and Control Plan are considered living documents and used as tools for continuous improvement throughout the life of the product.

4.2.8 Human Resources

Prior to the recent insolvency, Azure Dynamics employed a talented team of professionals including highly-skilled personnel in management, engineering, operations, administration, marketing and sales. Many of staff members were automotive industry veterans. Azure Dynamics employed 159 employees globally as at December 31, 2011, as disclosed in Table 22, of which at least 132 were involved in the engineering department in a variety of technical roles. The organization reporting structure is shown in Figure 32.

Location (Employer)	*Part-Time / Contract Employees*	*Full-Time Employees*	*Total*
Burnaby, BC (Azure Canada)	7	41	48
Detroit, MI (Azure US)	4	51	55
Boston. MA (Azure US)	2	43	45
Stevenage, UK (Azure UK)	2	9	11

Table 22 - Azure Dynamics - Employee Head Count by Location

Of these 159 employees, 132 were employed in an engineering or technical capacity. The organization reporting structure is shown in Figure 32.

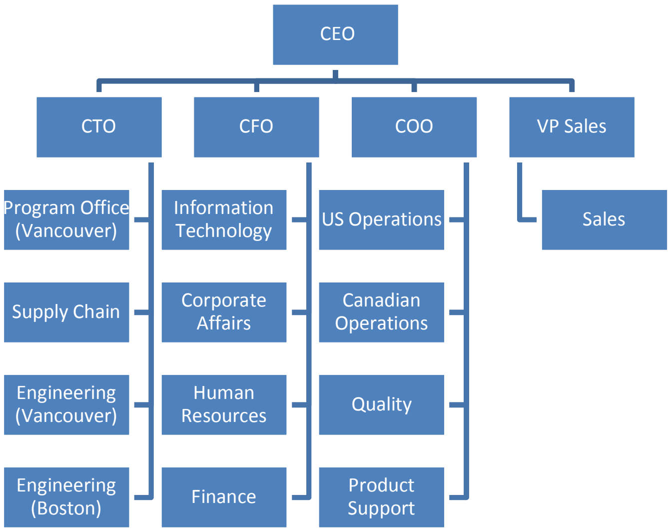


Figure 32 - Azure Dynamics Organization Structure

4.2.9 Research and Development

Research and development is a significant component of Azure's business and requires substantial and continuous funding. These research and development activities centre on the further development of Azure's core expertise, including the development of new generations of existing product lines, as well as the creation of new product lines (each discussed below), and related component products. The executive management and oversight of Azure's engineering and product development teams is based in Burnaby, British Columbia while engineering resources are located in Burnaby (controls software develop, vehicle integration) and in Woburn, Massachusetts (ForceDrive™ electric drive and inverter components).

Azure has three core competencies within the engineering team: Controls Software development, Systems Engineering and Vehicle Integration activities, and Power Electronics and Electric Drive Components development. These three areas are described in more detail below.

4.2.9.1 Controls Software

Azure's key technology is its controls software, which is found in all of its hybrid and electric vehicles. Azure's background spans many areas of electronic control system design: engine controls, transmission controls, induction and permanent magnet motor controls, generator controls, and other power conversion devices.

Azure control software for powertrain systems has been designed to use sophisticated mathematical algorithms to perform real-time analysis of on-board operating data. The performance analysis allows the control system to adapt to a variety of operating conditions. Unique control algorithms are included in Azure Force Drive® propulsion system components technology found in its electric vehicles to minimize energy consumption and maximize range.

Azure's new product development strategy emphasizes component reusability across product lines and platforms. The embedded control software structure is flexible and modular enough to be adapted and reused for different platform applications. Reusability is achieved by employing state-of-the-art methods such as model-driven development (MDD) in the design of new powertrain software components. The process allows Azure to shrink the development lifecycle for new vehicle control systems and reduces the iteration time between prototype and production software releases.

4.2.9.2 Power Electronics and Electric Machine Design

Another core competency area of Azure is the design of power electronics components, which are integral to the electrification of all types of alternative commercial vehicle powertrains including HEV, PHEV, and BEV trucks. Commercial trucking applications place a huge emphasis on component reliability: vehicle parts and sub-systems must meet stringent automotive and military environmental requirements. Appropriately, Azure Dynamics ForceDrive™ components have been deployed and field-proven over several millions miles of in-vehicle service with many different fleets.

4.2.9.3 Systems Engineering & Vehicle Integration

Since Azure was founded, it has completed many vehicle integration programs. Azure has adapted its powertrain systems to a variety of different vehicle applications using its electrical systems and powertrain design capability. Azure Dynamics engineers work closely with supply chain partners including battery suppliers such as Johnson Controls (JCI) and motor manufacturers such as Siemens to adapt their components to meet Azure's exacting vehicle program requirements. For instance, Azure has extensive background integrating lithium, NiMH and lead-acid battery packs with several vehicle chassis designs. In 2009, Azure worked with Johnson Controls (JCI) to develop a new lithium-ion hybrid battery pack for the Balance hybrid-electric truck. Later in 2010, Azure worked with JCI to develop a larger lithium-ion pack design for the TCE all-electric platform.

4.2.9.4 Intellectual Capital, Patents and Trade Secrets

The intellectual property and patents of Azure Dynamics can be divided into two category areas: (1) algorithm design for the control of power electronics, inverters, AC induction motors and electric powertrain components, and (2) embedded control software for managing vehicle powertrain systems, including complex algorithms to minimize energy consumption and thus maximize vehicle range.

Azure combines various approaches to establish and protect its proprietary intellectual capital including patents, industrial designs, copyrights, trademarks and trade secret laws. Azure takes appropriate steps to safeguard intellectual property using non-disclosure and confidentiality agreements for its employees and strategic partners and suppliers.

As of September 1, 2011 Azure has a total of 18 patents approved and 5 pending patent applications in the US. In other countries and jurisdictions, there are several related patents. See Table 23.

Patent Number	Title of Invention
Issued US 5,898,282 Canada 2,182,630	A Control System for a Hybrid Vehicle
Issued US 6,242,873 Canada 2,397,074 Granted also GB, FR, IT, DE & ES	Method and Apparatus for Adaptive Hybrid Vehicle Control
Issued US 6,555,991 Granted also CN, MX & SG, GB, FR, IT, DE, ES & HK Pending: CA 2,473,817,BR & IN	Battery Operating Condition Dependent Method and Apparatus for Controlling Energy Transfer Between an Energy Bus and a System of Batteries
Issued US 6,909,200 Granted also GB, FR, DE, ES, HK, MX, CN & SG Pending: CA 2,475,597, BR, IN & KR	Methods of Supplying Energy to an Energy Bus in a Hybrid Electric Vehicle, and Apparatuses, Media and Signals for the Same
Issued US 6,879,054 Granted also GB, FR, IT, DE, ES, CN, MX, SG & HK, Pending: CA 2,477,072, BR, IN & KR	Process, Apparatus, Media and Signals for Controlling Operating Conditions of a Hybrid Electric Vehicle to Optimize Operating Characteristics of the Vehicle
Issued US 5,562,178	Rear Drive Electric Vehicle
Issued US 5,637,971	Suppression of Multiple Noise-Related Signals in Pulse Width Modulated Signals
Issued US 5,808,427	Vehicle Drive Control System
Issued US 6,643,149	Switching System
Issued US 6,768,621	Contactor Feedback and Pre-Charge / Discharge Circuit
Pending: US2008/0132378 & CA 2,666,723	Method and Apparatus for Starting an Engine in a Hybrid Vehicle
Issued US 7,728,448 Pending: CA 2,650,224, EP & MX	Process and Apparatus for Reducing Nitrogen Oxide Emissions in Genset Systems
Issued US 7,577,006	Non-Linear Droop Control System and Method for Isochronous Frequency Operation
Pending US2008/0122228, CA 2,659,087 & EP	Method, Apparatus, Signals and Media for Selecting Operating Conditions of a Genset
Issued US 7,826,939, CA 2,661,718 & EP	Method, Apparatus, Signals and Media for Managing Power in a Hybrid Electric Vehicle
Issued US 7,397,675	Inverter-Filter Non-Linearity Blanking Time and Zero Current Clamping Compensation System and Method
Issued US 7,561,008 Pending: CA 2,677,293 & EP	Improved Filter package
Issued US7,741,798 Pending: CA 2,669,085 & EP	RFI/EMI Filter for Variable Frequency Motor Drive System
Issued US 7,560,895 Pending:	CA 2,681,037 & EP, Indirect Rotor Resistance Estimation system and Method
Pending: US 2010/0251984, CA20709022, & EP	Method and Apparatus for Starting an Internal Combustion Engine
Issued US 7,893,650 Pending: CA 2,713,403 MX & EP	Method and System for Multiphase Current Sensing

Table 23 - Azure Dynamics Patent Portfolio

4.2.10 Supply Chain Management

Azure's supply-chain management team provides strategic support for other corporate functions including the design, engineering and customer service teams. Approved vendor decisions are made after extensive cross-functional review of a potential supplier's capabilities, commercial competitiveness and overall financial status. An in-depth evaluation of a supplier's manufacturing operation and management system is performed to assess strengths and weaknesses in satisfying Azure requirements and the customer's requirements prior to finalizing a source decision. Key component suppliers must be ISO9001 certified (preferably TS16949 certified) and demonstrate a stable management operating system. Supplier parts are not authorized for production until all requirements of the Production Part Approval Process (PPAP) verifying form, fit and functionality to prescribed specifications are met.

4.2.11 Manufacturing Management

Azure has a small manufacturing engineering and operations management team that works closely with the upfitters as onsite quality ambassadors. The main function of the manufacturing engineering team is to coordinate build schedules, to document and hand over bills-of-materials (BOMs) and factory work instructions to the production line, to provide oversight to ensure that the production parts approval (PPAP) process is followed and that running changes are implemented properly on the line, and to provide feedback to Azure's engineering team on manufacturing problems at the upfitter facility.

4.3 Azure Dynamics Core Competencies

An analysis of Azure's capabilities and core competencies was performed using Barney's VRIO (Value, Rarity, Imitability, Organization) framework (Barney, 1995), but adapted to use Grant's method for the functional classification of an organization's capabilities (Grant, 2008). Using the following VRIO attributes, we can determine which of Azure's capabilities can be considered core competencies with competitive potential:

1. **Value**: Can the resource or capability enable a firm to take advantage of an external opportunity or counteract an external threat?
2. **Rarity**: Is a resource or capability controlled by a few rivals in the industry?
3. **Imitability**: For any firm lacking a resource or capability, is there a significant cost disadvantage if the firm attempts to obtain or develop it? Is the resource costly to imitate?
4. **Organization**: Is a firm organized and ready to exploit the valuable, rare and inimitable resources or capabilities?

4.3.1 Core Competency Analysis Using VRIO Framework

Figure 33 and Figure 34 provide a detailed view of the Core Competency Analysis, with the resources and capabilities within Azure Dynamics rated as providing an advantage, neutral playing field, or disadvantage. A summary of the resources and capabilities that provide an advantage (those items shown in green in the detailed VRIO analysis) is provided in Table 24.

Azure Dynamics - Core Competency Analysis Using VRIO Framework

VRIO Framework adapted from
J. B. Barney, "Firm resources and sustained competitive advantage"

Resources Classification and Functional Classification of Organizational Capabilities adapted from
Robert M. Grant, "Contemporary Strategy Analysis"

Legend

- Core Competence
- Neutral Competitive Advantage - Mandatory Threshold Capability (price of admission to market)
- Competitive Disavantage - core or threshold capability declining
- Competitive Disavantage - core or threshold capability not present originally or lost after insolvency
- Neutral Competitive Advantage - optional capability
- Optional (non-threshold) capability lost but no disadvantage

Category / Function	Item #	Resource / Capability	V - Valuable	R - Rare	I - Imitation Costly?	Loc'n (Vanc,Det,Bos,UK,All)	Pre-Insolvency					Post Insolvency				
							O - Organization Exploits Cap. (Y, N, A=absent)	Core Competency?	Competitive Advantage Implications	Economic Implications	Strength or Weakness	O - Organizational Capability Exploited? (Y, N, or A=absent)	Core Competency?	Competitive Advantage Implications	Economic Implications	Strength or Weakness
Tangible Resources																
Financial	R1	Cash and cash equivalents	Y	N	N	A	Y	N	Disadvantage	Below Normal	Weak	N	N	Disadvantage	Below normal	Weak
	R2	Capacity to raise equity	Y	N	N	A	Y	N	Parity pre-2011, Disadv. 2011-2012	Normal pre-2011, Below Normal 2011+	Normal up to 2010, Weak 2011-2012	N	N	Disadvantage	Below normal	Weak
	R3	Borrowing Capacity	Y	N	N	A	N	N	Parity	Normal	Neutral	N	N	Disadvantage	Below normal	Weak
Physical	R4	Modern Vehicle Integration Facilities	Y	N	N	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R5	State-of-the-art testing equipment	Y	N	N	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R6	Favorable locations	Y	N	N	A	Y	N	Parity	Normal	Neutral	A	-	-	-	-
Intangible Resources																
Technology and Intellectual Property	R7	Trade Secrets (HEV, PHEV and BEV powertrain system designs)	Y	N	Y	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R8	Patents (HEV, BEV, PHEV system energy management and control)	Y	Y	Y	V	Y	Y	Advantage	Above Normal	Strength	Y	Y	Advantage	Above Normal	Strength
	R9	Patents (Power electronics component design)	Y	Y	Y	B	Y	Y	Advantage	Above Normal	Strength	N	N	Disadvantage	Below normal	Weak
	R10	Copyrights, trademarks	N	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
Reputation	R11	Reputation with customers for quality and reliability	Y	N	Y	A	Y	N	Parity	Normal	Neutral	Y	N	Disadvantage	Below normal	Weakening
	R12	Reputation with suppliers for fairness, and non-zero-sum relationships	Y	N	Y	A	Y	N	Parity	Normal	Neutral	Y	N	Disadvantage	Below normal	Weakening
Culture, Innovation and Creativity	R13	Customer Focus	Y	N	N	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R14	Creativity	Y	N	N	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R15	Innovation Capacities	Y	N	Y	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
Human Resources																
Human Resources	R16	Skills / Know-how	Y	N	Y	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R17	Capacity for communication and collaboration	Y	N	Y	A	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	R18	Leadership and Motivation	Y	Y	Y	A	N	N	Parity	Normal	Neutral	N	N	Parity	Normal	Neutral
	R19	Ability to hire, motivate and retain human capital	Y	N	Y	A	Y	N	Parity	Normal	Neutral	N	N	Disadvantage	Below normal	Weakening

Figure 33 - Azure Dynamics Core Competencies Using VRIO Framework - Part 1 of 2

Category / Function	Item #	Resource / Capability	V - Valuable	R - Rare	I - Imitation Costly?	Loc'n (Vanc,Det,Bos,UK,All)	Pre-Insolvency					Post Insolvency				
							O - Organization Exploits Cap. (Y, N, A=absent)	Core Competency?	Competitive Advantage Implications	Economic Implications	Strength or Weakness	O - Organizational Capability Exploited? (Y, N, or A=absent)	Core Competency?	Competitive Advantage Implications	Economic Implications	Strength or Weakness
Organizational Capabilities																
Corporate Functions	C1	Financial Controls and Cash Flow Management	Y	N	N	A	N	N	Disadvantage	Below Normal	Weak	Y	N	Parity	Normal	Neutral
	C2	Strategic Alliances and Business Development	Y	Y	Y	A	Y	Y	Advantage	Above Normal	Strength	N	N	-	-	-
	C3	Strategic Planning and Acquisition Management	Y	Y	Y	D	N	N	Disadvantage	Below Normal	Weak	N	N	Disadvantage	Below normal	Weakening
Management Information	C4	Corporate CRM and MRP systems for operations management	Y	N	Y	V	Y	N	Parity	Normal	Neutral	N	N	Disadvantage	Below normal	Weakening
	C5	Corporate intranet and knowledge base	Y	N	N	v	Y	N	Parity	Normal	Neutral	N	N	Disadvantage	Below normal	Weakening
	C6	IT network management and server infrastructure	Y	N	N	a	Y	N	Parity	Normal	Neutral	N	N	Disadvantage	Below normal	Weakening
Engineering and R & D	C7	Control software for AC induction and permanent magnet electric motors	Y	Y	Y	B	Y	Y	Advantage	Above Normal	Strength	A	-	-	-	-
Controls Software	C8	Control software for transmissions, generators, power inverters, DC-DC converters and other power conversion devices.	Y	N	N	B	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C9	Closed-loop control algorithms and powertrain torque monitor software to control engine torque. Responds to real-time analysis of vehicle operating data and sensory inputs and balances power distribution between traction motor and IC engine (in hybrid systems).	Y	N	Y	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	C10	Expertise in model-driven architectures (MDA) to decrease the time between prototype and production level software.	Y	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	C11	Software reuse across multiple platforms.	N	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
Power Electronics Design	C12	Expertise in analog and digital electronics design for power conversion components including DSP controlled power supplies, AC power inverters (based on IGBT technology and DSP control), DC/DC converters, electric motors and integrated starter generator (ISG) systems.	Y	Y	Y	B	Y	Y	Advantage	Above Normal	Strength	A	-	-	-	-
	C13	Development of custom power electronics and subassemblies to meet stringent automotive environmental requirements.	Y	Y	Y	B	Y	Y	Advantage	Above Normal	Strength	A	-	-	-	-
Systems Engineering & Vehicle Integration	C14	Expertise in "right sizing" and matching hybrid-electric and battery electric vehicle components: lithium-ion battery packs, electric motors, and transmissions. "Right-sizing" helps to reduce initial capital costs and operating costs (lower fuel consumption) compared to other hybrid or electric technologies.	Y	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	C15	Design of xEV Energy Management Systems and optimal control strategies and algorithms to manage powertrain operating state to guarantee optimal efficiency and performance (to minimize energy consumption and maximize range).	Y	Y	N	V	Y	Y	Temporary Advantage	Above Normal (in short term)	Strength	Y	Y	Temporary Advantage	Above Normal (in short term)	Strength
	C16	Expertise in working with industry-leading electric motor manufacturers to modify their designs to meet specific program requirements and to secure validated and warranted solutions.	Y	N	N	B	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C17	Expertise in understanding the interaction of HEV/EV components with the base vehicle as a system (so that it can design systems to satisfy performance and safety requirements)	Y	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	C18	Expertise in platform customization and adapting vehicle powertrain and electrical system designs to different vehicle applications .	N	Y	Y	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
	C19	Expertise in mounting and integrating energy storage solutions, including Li-Ion, nickel cadmium, nickel–metal hydride ("NiMH") and lead-acid batteries and ultra-capacitors.	Y	N	N	V	Y	N	Parity	Normal	Neutral	Y	N	Parity	Normal	Neutral
Operations	C20	Quality Management Systems	Y	N	N	A	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C21	Operations Effectiveness (Supply Chain, Logistics, and Inventory Control)	Y	N	N	A	N	N	Disadvantage	Below Normal	Weak	A	-	-	-	-
	C22	Customer Support and Warranty Service Capability	Y	N	N	V	Y	N	Parity	Normal	Neutral	A	-	-	-	-
Marketing	C23	Brand Management	Y	N	N	D	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C24	Outbound Marketing / Advertising / Collateral	Y	N	N	D	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C25	Inbound Marketing and Product Management	Y	N	N	D	Y	N	Parity	Normal	Neutral	A	-	-	-	-
Sales and Distribution	C26	Sales Forecasting	Y	N	N	D	N	N	Disadvantage	Below Normal	Weak	A	-	-	-	-
	C27	North American Market Share and Dealer Network	Y	N	Y	D	Y	N	Parity	Normal	Neutral	A	-	-	-	-
	C28	European Market Share and Dealer Network	Y	N	Y	UK	Y	N	Parity	Normal	Neutral	A	-	-	-	-

Figure 34 - Azure Dynamics Core Competencies Using VRIO Framework - Part 2 of 2

Table 24- Summary of Azure Dynamics Core Competences - Pre- and Post-Insolvency

Item #	Resource / Capability	Core Competency Pre-Insolvency?	Core Competency Post-Insolvency?	Comments
R8	Patents (HEV, BEV, PHEV system energy management and control)	Y	Y	The Vancouver group's system-level patents are still a core competence post-insolvency as long as key Vancouver employees are retained.
R9	Patents (Power electronics component design)	Y	N	Azure retains the patent ownership, post insolvency, but the Boston office's component-level patents are no longer a core competence post-insolvency as critical employee know-how with respect to patents was laid off or left after the Boston office closure.
C2	Strategic Alliances and Business Development	Y	N	Ability to form partnerships with firms such as Ford, Johnson Controls and Utilimaster was a core competence pre-insolvency. The capability to negotiate partner alliances has been affected as a result of the insolvency until financial restructuring issues are resolved.
C7	Control software for AC induction and permanent magnet electric motors	Y	N	This core competency was lost when Boston office closed after insolvency
C12	Expertise in analog and digital electronics design for power conversion components including DSP controlled power supplies, AC power inverters (based on IGBT technology and DSP control), DC/DC converters, electric motors and integrated starter generator (ISG) systems.	Y	N	This core competency was lost when Boston office closed after insolvency
C13	Development of custom power electronics and subassemblies to meet stringent automotive environmental requirements.	Y	N	This core competency was lost when Boston office closed after insolvency
C15	Design of xEV Energy Management Systems and optimal control strategies and algorithms to manage powertrain operating state to guarantee optimal efficiency and performance (to minimize energy consumption and maximize range).	Y	Y	This is a core competency pre- and post-insolvency (valuable, rare, and exploited by organization), but since it is not costly to imitate, it is only a temporary advantage.

The core resources (EV patent portfolio) are described in the value chain analysis earlier in this chapter in section 4.2.9.4. The core competencies (controls software development skills, power electronics design capability, systems engineering proficiency and vehicle integration knowledge) are described in sections 4.2.9.1 to 4.2.9.3.

4.3.2 Core Competencies Mapped to Strategic Assets

A list of core competencies can be used further to derive the strategic assets of a firm. By examining the assets in the context of key success factors for the industry, we establish whether these assets will allow a firm to extract or derive economic rents in the industry and whether there is a basis for sustained competitive advantage.

Azure is organized to exploit its core competencies by integrating its core ForceDrive component technologies and powertrains into robust commercial vehicle designs targeted at urban delivery, postal, courier, taxi and shuttle-bus fleets in the light to medium duty commercial vehicle markets. The mapping of core competencies to strategic assets is shown in Figure 35.

The electric and hybrid technology benefits from some of the inherent inefficiencies in the nature of the drive-cycle of these applications and eliminates other inefficiencies thereby achieving fuel and maintenance cost reductions, as well as reductions in the harmful emissions that contribute towards health and environmental issues. For example, the short trip, stop-start nature of these applications enable the EV and HEV systems to regenerate power by capturing braking energy that is then used to recharge the battery thereby extending the operational range of the vehicle. Azure's HEV system allows the combustion engine to operate at those times and at those levels where it is most efficient, and it operates with an electric-assist or full-electric mode at times when it is not efficient, thereby reducing fuel consumption, emission outputs and noise levels.

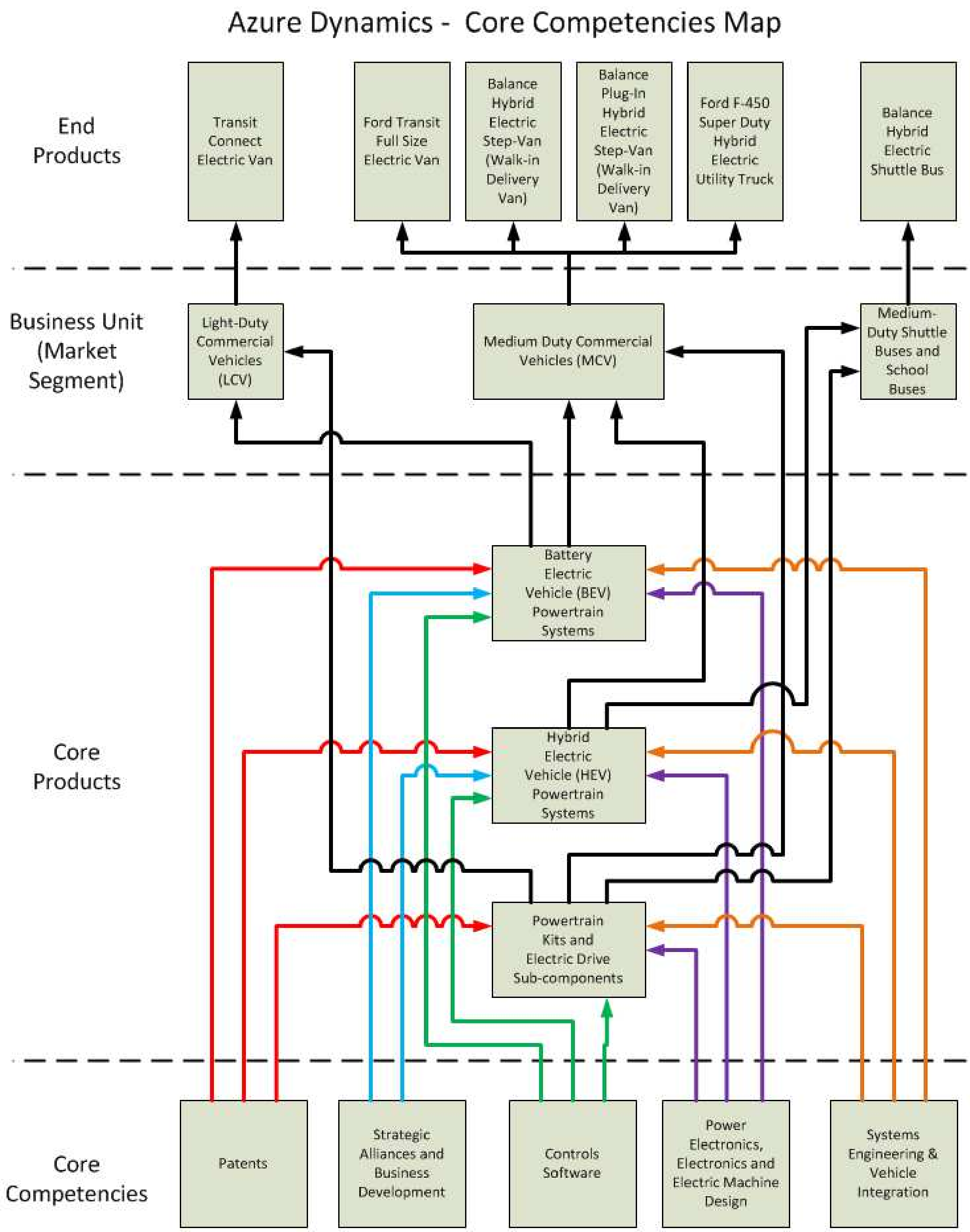


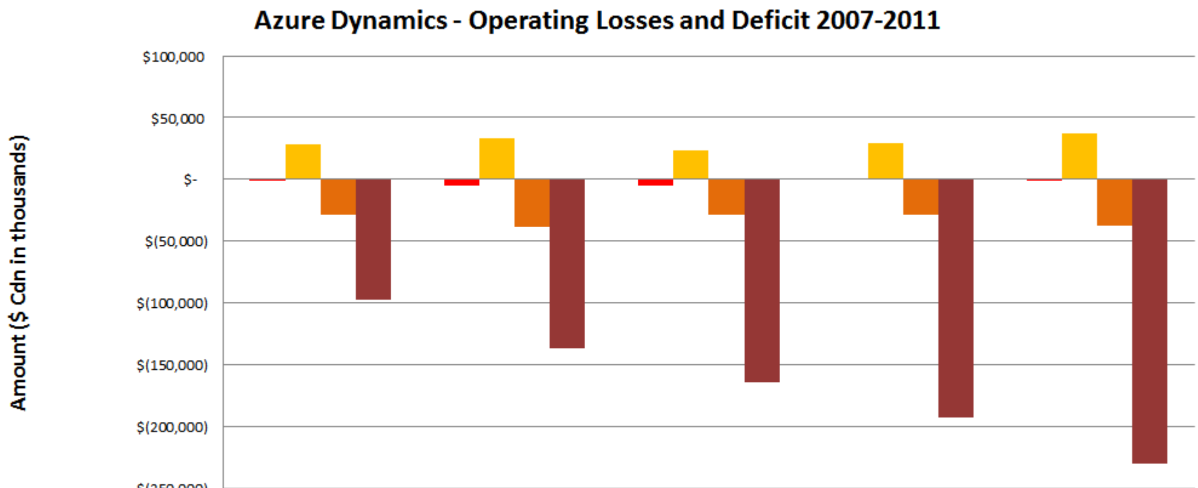
Figure 35- Core Competencies Mapped to Strategic Assets

5 Financial Performance

This chapter provides an analysis of Azure's financial performance and financial resources. The review looks at Azure's financial history over the last 5 years, identifying important trends. It also provides a specific look at events leading up to the Azure Dynamics insolvency in March 2012, and some of the restructuring activities both pre- and post-insolvency.

5.1 Financial History

Although Azure is almost 15 years old, it is still in an early-stage firm in terms of the maturity of its technology development and business model. Since it was founded, Azure has incurred considerable losses. Figure 36 highlights Azure's operating losses and cumulative deficit for the last 5 years.



	2007	2008	2009	2010	2011
Gross Margin	$(297)	$(5,215)	$(5,117)	$289	$(213)
Total Expenses	$28,186	$33,018	$23,203	$29,141	$37,493
Operating Income (Loss)	$(28,483)	$(38,233)	$(28,320)	$(28,852)	$(37,706)
Deficit (cumulative losses)	$(97,864)	$(136,731)	$(164,539)	$(192,665)	$(229,946)

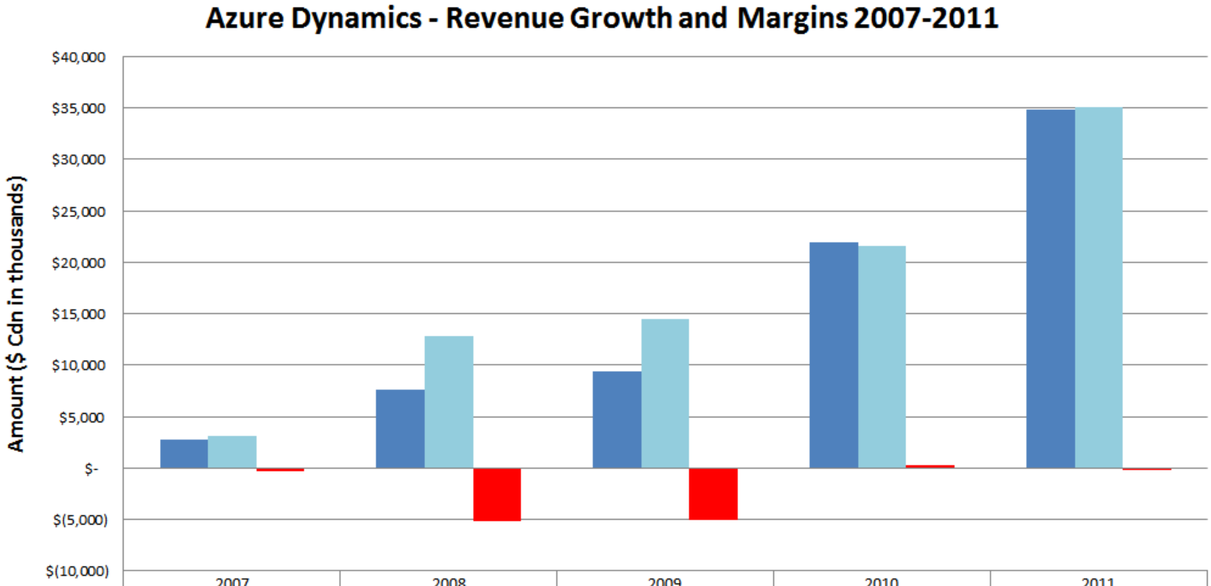
Figure 36 - Azure Dynamics Operating Losses and Deficit 2007-2011

As mentioned in the introduction, up until 2007 Azure was developing their hybrid technology and building technology demonstration prototypes. Since 2007, Azure has turned its focus to commercial vehicle production and customer sales.

Table 25 provides selected financial data for Azure Dynamics over the last 5 years. Azure has not yet displayed that it is even capable of consistently attaining positive gross margins, let alone attaining any level of profitability. On-going efforts by Azure to reduce product costs have not been sufficient to cover operating expenses by increasing sales volume with positive margins. Figure 37 provides the revenue and gross margin history for 2007-2011. The biggest expense category is research and development (R&D) which varies between 50-65% of total expenses.

	2007	2008	2009	2010	2011
Balance Sheet					
Total Current Assets	$ 36,754	$ 25,113	$ 42,409	$ 28,206	$ 31,176
Total Assets	$ 55,887	$ 43,691	$ 58,414	$ 43,378	$ 42,475
Total Current Liabilities	$ 4,476	$ 5,354	$ 10,748	$ 18,639	$ 20,623
Long-Term Debt	$ 3,005	$ 3,561	$ 2,816	$ 673	$ 8,575
Total Liabilities	$ 7,481	$ 8,915	$ 13,564	$ 19,312	$ 29,198
Shareholders' Equity	$ 48,406	$ 34,776	$ 44,850	$ 24,066	$ 13,277
Liabilities & Shareholders' Equity	$ 55,887	$ 43,691	$ 58,414	$ 43,378	$ 42,475
Deficit (cumulative losses)	$ (97,864)	$ (136,731)	$ (164,539)	$ (192,665)	$ (229,946)
Income Statement					
Revenues	$ 2,801	$ 7,651	$ 9,403	$ 21,913	$ 34,807
Cost of Sales	$ 3,098	$ 12,866	$ 14,520	$ 21,624	$ 35,020
Gross Margin	$ (297)	$ (5,215)	$ (5,117)	$ 289	$ (213)
R & D Expenses	$ 16,690	$ 22,286	$ 11,681	$ 17,028	$ 23,897
Sales and Marketing Expenses	$ 3,683	$ 3,418	$ 2,388	$ 2,784	$ 3,744
General and Admin. Expenses	$ 7,813	$ 7,314	$ 9,134	$ 9,329	$ 9,852
Operating Income (Loss)	$ (28,483)	$ (38,233)	$ (28,320)	$ (28,852)	$ (37,706)
Net Income (Loss)	$ (30,235)	$ (38,867)	$ (27,808)	$ (28,126)	$ (37,281)
Outstanding Shares	214,273,669	313,802,407	406,148,487	616,823,270	694,788,000
Loss per share	$ (0.14)	$ (0.12)	$ (0.07)	$ (0.05)	$ (0.05)
Statement of Cash Flows					
Cash from operating activities	$ (29,191)	$ (33,403)	$ (17,072)	$ (26,394)	$ (34,187)
Cash from financing activities	$ 27,822	$ 24,276	$ 37,009	$ 5,949	$ 28,963
Cash from investing activities	$ (1,923)	$ (1,232)	$ (98)	$ (1,344)	$ 92
Net Increase (Decrease) in cash	$ (3,292)	$ (10,359)	$ 19,839	$ (21,789)	$ (5,132)

Table 25 - Selected Azure financial data for 2007-2011 (in thousands of Cdn $)



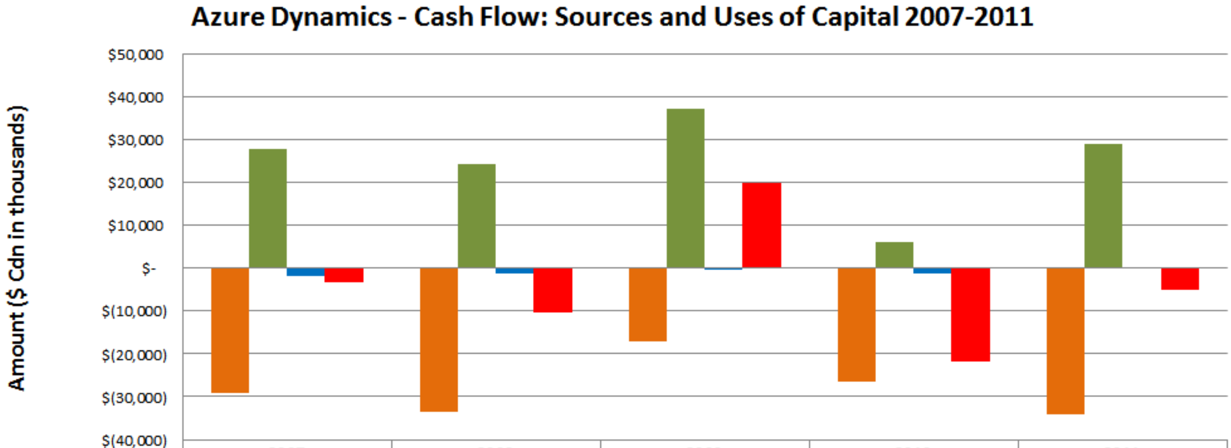
	2007	2008	2009	2010	2011
Revenues	$2,801	$7,651	$9,403	$21,913	$34,807
Cost of Sales	$3,098	$12,866	$14,520	$21,624	$35,020
Gross Margin	$(297)	$(5,215)	$(5,117)	$289	$(213)

Figure 37 - Azure Dynamics - Revenue Growth and Margins 2007-2011

Prior to insolvency, Azure depended on equity financing, government loans, and NRE funding from partners to cover operating expenses. Table 26 lists share offerings since 1997. Figure 38 demonstrates that cash to operations has essentially been matched by cash from financing.

Date	Form of transaction	Amount (millions $Cdn)
Jan-02	Private placement	5.2
Nov-02	Private placement	0.8
Jul-03	Private placement	2.2
Dec-03	Private placement	10.7
Mar-04	Private placement	4.2
Jul-04	Public offering	2.6
Nov-04	Warrant exercise	7.8
Feb-05	Private placement	11.6
Jul-05	Warrant exercise	3.4
Sep-05	Private placement	11.0
Nov-06	Public offering	24.5
Nov-06	Private placement	3.3
Nov-06	Overallotment Options Exercise	2.5
Oct-07	Public Offering	27.8
Aug-08	Private placement	24.3
Aug-09	Private placement	10.0
Dec-09	Public offering	30.0
Jun-10	Private placement	6.3
Feb-11	Public offering	20.1
Nov-11	Private placement	5.1
Nov-11	Public offering	3.8
Nov-11	Overallotment Options Exercise	0.9
	Total	**$218.1 million**

Table 26 – Azure Dynamics – Equity Funding and Investment Since Incorporation 1997-2012



	2007	2008	2009	2010	2011
Cash to operations	$(29,191)	$(33,403)	$(17,072)	$(26,394)	$(34,187)
Cash from financing	$27,822	$24,276	$37,009	$5,949	$28,963
Cash to investing	$(1,923)	$(1,232)	$(98)	$(1,344)	$92
Net Change in Cash	$(3,292)	$(10,359)	$19,839	$(21,789)	$(5,132)

Figure 38 - Azure Dynamics Cash Flow (Sources and Uses of Capital) 2007-2011

The repeated share offerings resulted in considerable dilution of the holdings of shareholders of Azure and had a negative impact on the market price of the common shares of Azure. Figure 39 and Figure 40 show the share price history, the market capitalization and outstanding shares.

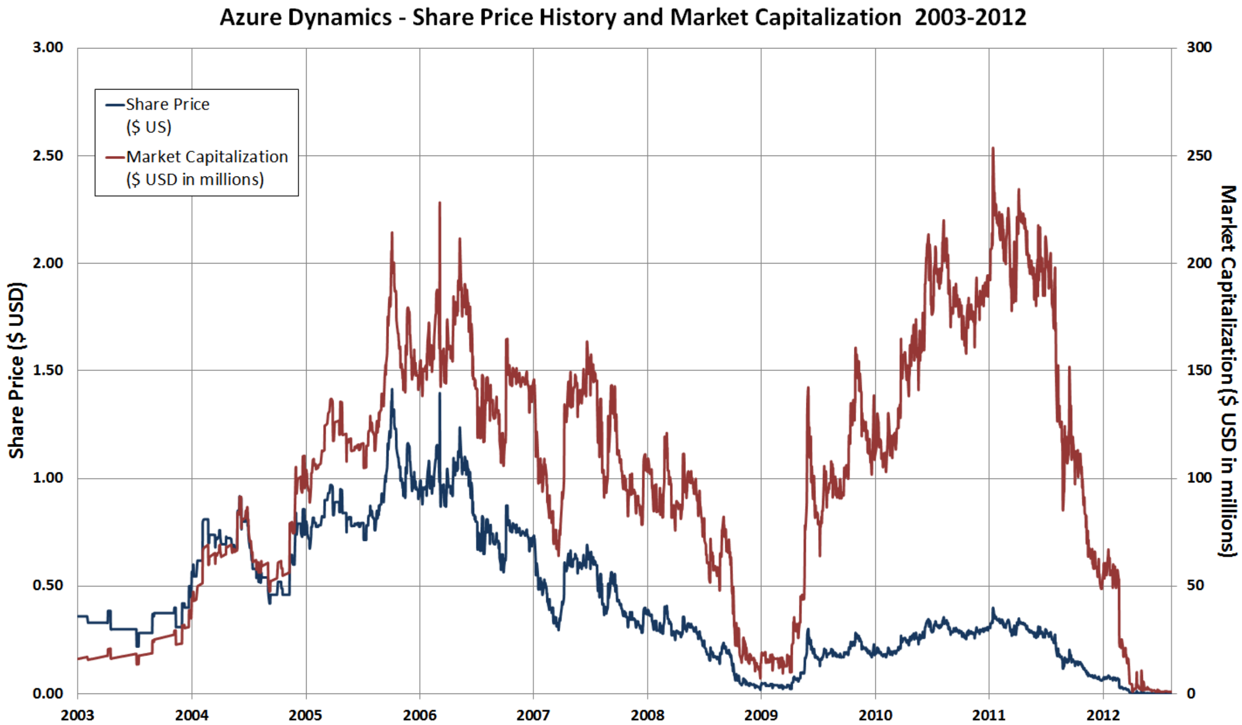


Figure 39 - Azure Dynamics - Share Price History and Market Capitalization 2003-2012

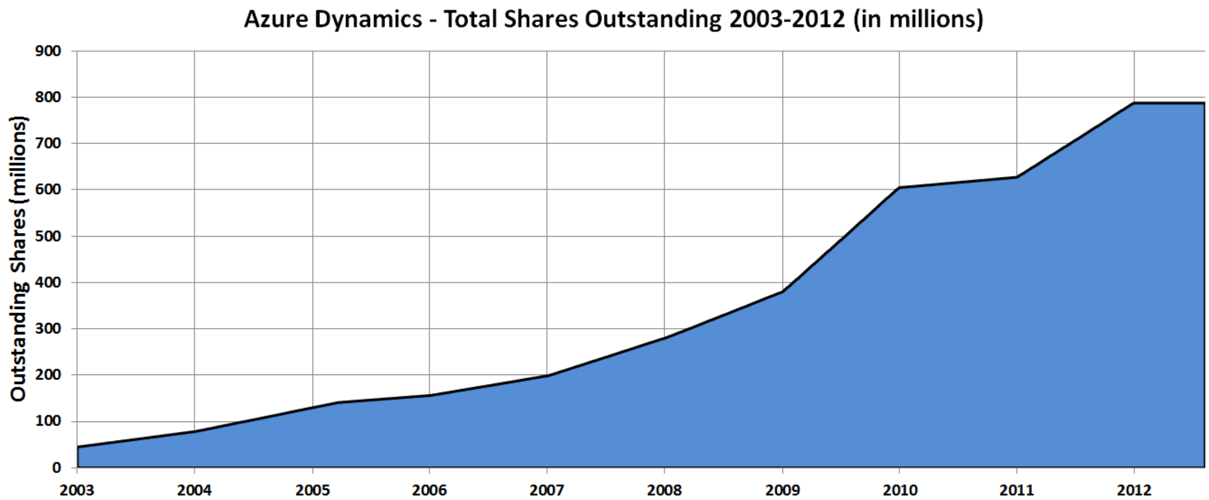
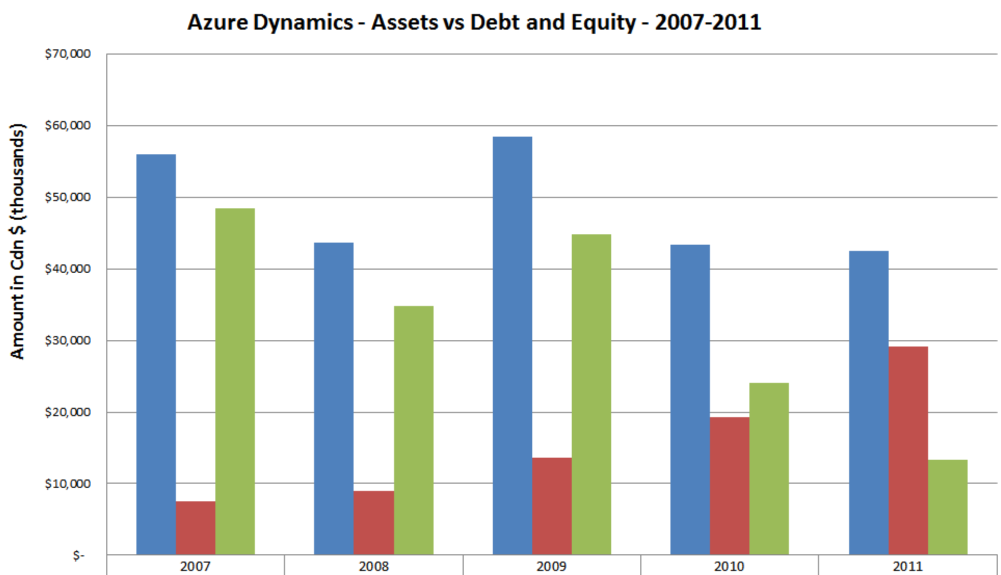


Figure 40 - Azure Dynamics - Total Shares Outstanding 2003-2012 (millions)

Azure's growing deficit from accumulated losses has reduced shareholders' equity over the last five years, and has increased the liquidity risk. The chart in Figure 41 illustrates that the shareholders' equity as a proportion of total assets has decreased substantially. Table 27 provides an analysis of key financial ratios for the last 5 years. Apart from a troublesome deficit, thin gross margins, and the necessity to raise capital to finance operating losses, there is a weakening trend in the solvency ratios. Solvency is the ability of Azure to meet its long-term expenses and to support growth and expansion. The debt-to-equity ratio (D/E ratio) has from a relatively low level of 0.15 in 2007 to 2.2 in 2011.The D/E ratio measures the relative share of equity and debt used to finance a company. The relatively high ratio of 2.2 in 2011 illustrates that the company is much more heavily leveraged now. Although Azure Dynamics has financed its transition to production and its expansion to sales in Europe through growing debt, the erosion of the equity value of the company (from the growth in the deficit) is equally responsible for the growth in the D/E ratio. The interest expense burden of the firm has increased over the last five years. If Azure is liquidated after several attempts to restructure the firm during CCAA proceedings, then the D/E ratio of 2.0 also indicates that there is significant risk that shareholders' equity may not completely fulfil Azure's obligations to creditors.



	2007	2008	2009	2010	2011
Assets	$55,887	$43,691	$58,414	$43,378	$42,475
Total Liabilities	$7,481	$8,915	$13,564	$19,312	$29,198
Shareholders' Equity	$48,406	$34,776	$44,850	$24,066	$13,277

Figure 41 - Azure Dynamics - Assets vs. Debt and Equity 2007-2011

Indicator or Ratio	2007	2008	2009	2010	2011
Current Ratio **(CA / CL)**	8.21	4.69	3.95	1.51	1.51
Quick Ratio (Acid-Test) **((CA - Inv) / CL)**	5.93	3.14	3.46	1.22	0.59
Debt to Assets **(Long-term Debt / Total Assets)**	0.05	0.08	0.05	0.02	0.20
Debt to equity **(Total Debt/Total Equity)**	0.15	0.26	0.30	0.80	2.20
Leverage **(Total Assets / Stockholders Equity)**	1.15	1.26	1.30	1.80	3.20
Inventory turnover **(Total Sales / Total Value of Inventory)**	5.48	5.25	11.20	7.85	2.22
Average Collection Period **(Accounts Receivable/ Sales Per Day)**	76.88	110.54	102.17	167.28	50.14
Sales to fixed assets **(Sales / Assets)**	0.06	0.23	0.19	0.63	0.99
Profit Margin on Sales **(Net Income / Total Sales)**	-10.79	-5.08	-2.96	-1.28	-1.07
Return on Equity **(Net Income / Stockholders Equity)**	-0.59	-1.10	-0.63	-1.20	-2.84
Return on Total Assets **(Net Income / Total Assets)**	-0.54	-0.89	-0.48	-0.65	-0.88

Table 27 - Ratio Analysis of Azure Dynamics 2007-2011

There is also a disturbing trend in liquidity in 2011. Liquidity measures the ability of Azure to convert assets to cash quickly. The common measures of liquidity are the Current Ratio (current assets / current liabilities) and the Quick Ratio or Acid Test Ratio (cash and cash equivalents + receivables + short-term investments/ current liabilities). The current ratio has decreased from 8.21 in 2007 to 1.51 in 2011. The quick ratio has decreased from 5.93 in 2007 to a dangerously low figure of 0.59 in 2011. A value less than 1 indicates that the Current Assets balance was lower than the Current Liabilities (no flexibility to pay off short term liabilities).

5.2 Azure Dynamics Insolvency

In this section, factors leading to the Azure Dynamics insolvency on March 26th, 2012 are considered. Essentially, there were four contributing factors:

i. Lack of available equity financing
ii. Severe 2011 sales shortfall
iii. Unnecessarily rapid expansion of headcount in 2010 and 2011
iv. Lack of adequate inventory control

When taken individually, each of these problems was serious enough, but the confluence of these factors proved disastrous; it was in essence a “perfect storm”. These are discussed in more detail below.

5.2.1 Lack of Available Financing

In late 2009 and early 2010, Azure Dynamics continued to pursue commercialization of their existing technologies and signed a key supply agreement with Ford to develop an electric version of the Ford Transit Connect van for sale and distribution in North America and Europe. This agreement required Azure Dynamics to undertake an aggressive outsourced Transit Connect Electric production program with upfitter AMG in North America and Lotus Lightweight Structures in Europe. Concurrently, Azure Dynamics continued product development initiatives on the plug-in hybrid (PHEV) version of the Balance product line based on the Ford E-450 chassis (for medium-duty walk-in delivery vans). Azure also engaged in discussions with Ford on electrification of the Ford Super-Duty F-450/F-550 truck platform and the full-size Ford Transit van platform.

Realizing that it would require significant capital to embark on these new development programs, in the 2nd quarter of 2011 Azure started planning to list their common shares on the NASDAQ Exchange and to complete a significant $75 million equity financing in the fourth quarter of 2011 in the United States and Canada. However, by the end of the 2nd quarter of 2011, Azure’s attempt to list Azure stock on NASDAQ was postponed. Financial advisors then felt that it would be difficult for Azure to raise capital because of the tight US equity capital markets. Economic conditions softened in the spring and summer of 2011 (particularly for clean technology investments) because of the sovereign state debt crisis in Europe, and prolonged US housing and employment issues.

After the NASDAQ listing failed, Azure pursued alternative financing opportunities in the 3rd quarter of 2011, principally in the Canadian capital markets. There was little appetite for further investment and Azure was unable to raise enough capital to support the ambitious 2011 business plan. Azure pursued a scaled-back business plan. In November 2011, Azure completed raising $5 million in a private placement by Johnson Controls, followed by issuing a short form prospectus for a public offering of shares for proceeds of $6,050,000. The proceeds of the November offering together with the proceeds of the Johnson Controls placement provided only enough funds to last about six months, given Azure's expense burn rate of over $2 million per month.

5.2.2 Sales Shortfall

Azure provided sales volume and revenue estimates for the 2011 fiscal year total in March 2011, the first time the company had ever provided forward-looking statements in the form of revenue guidance to shareholders. As of March 2011, Azure management provided a rosy estimate for annual revenue. Azure expected sales to range from a minimum of $52 million to a maximum of $68 million $Cdn, based on unit volumes of 700 to 800 Balance Hybrid trucks and 600-700 Transit Connect Electric trucks. At that time, the sales forecast was based on purchase orders in hand of $25 million, pending orders of $10 million, and forecast orders from qualified customers of $30 million. The most likely estimate was about $65 million. Figure 42 provides a chart of Azure revenue guidance revisions throughout 2011.

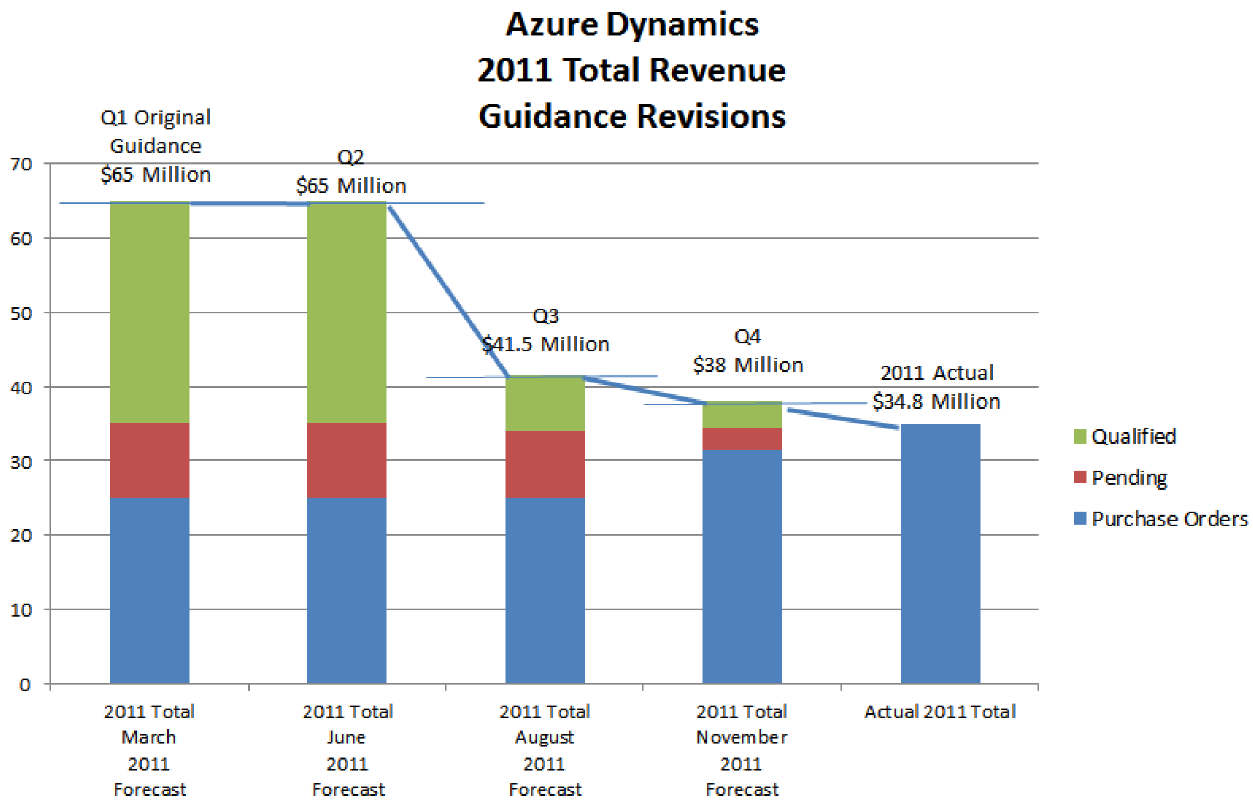


Figure 42 - Azure Dynamics 2011 Total Revenue - Guidance Revisions

In June 2011, Azure reaffirmed the previous revenue guidance figures from March of $52 to $68 million. In August 2011, citing continued instability in the European economy and soft sales in the US, Azure downgraded the expected 2011 revenue estimate from $65 million to $41.5 million with a range variance from $38 million to $45 million. In November 2011, Azure revised revenue guidance estimates yet again, and this time estimated that the most likely total was closer to $38.5 million than $41.5 million. However, 2011 4th quarter sales were dismal and as a result, the actual revenue 2011 sales revenue for Azure was only $34.8 million.

Due to the lead times to procure major components such as battery packs, Azure Dynamics must place orders in anticipation of forecasted orders (sometimes referred to as a risk-buy) as much as two quarters in advance. Because of the reduced sales volume in Q4 2011, the inventory on hand grossly exceeded that which was required to meet the actual demand for the period, further restricting the cash liquidity of Azure Dynamics. Azure's inventory grew to over $18 million in Q4 2011.

Although there was an unforeseen economic downturn in the middle of the year, the fact remains that the original $65 million annual sales estimate of $65 Million was almost 2 times greater than the actual revenue of $34.8 million for the year. It is possible that in the sales funnel forecast, either the probabilities of landing sales orders with prospect clients were overly optimistic, or else the quantities of the expected orders were vastly overestimated.

5.2.3 Rapid Expansion of Headcount 2010-2011

The Azure headcount rose from 112 in April 2009 to 192 in November 2011, an increase of about 71% (Figure 43). The expenses burn rate increased from about $1.82 million per month, to $2.2 million per month, an increase of about 21% from April 2009. Considering that Azure's series of recurring operating losses has been almost entirely funded by selling equity shares and that consistent positive gross margins have proved elusive, undertaking any expansion of the staff by 71% over two years without funding the extra expenses from internally generated working capital was a huge risk.

The increase in the headcount (predominantly in the engineering and R&D area) was being driven by the need to concurrently proceed with the Transit Connect Electric project at the same time as the Balance PHEV project, the Ford F-450 Super Duty PHEV project, and the Ford Transit full size project. With a poor liquidity situation, unproven market demand, a lack of a defined roadmap for achieving positive gross margins and profitability, any attempts to raise capital to expand the headcount is a highly risky undertaking. A more conservative strategy of completing the engineering projects in a serial fashion (one after another) rather than in parallel would be a less risky approach if it could be done without expanding the headcount beyond 104 employees on the engineering team in January 2010.

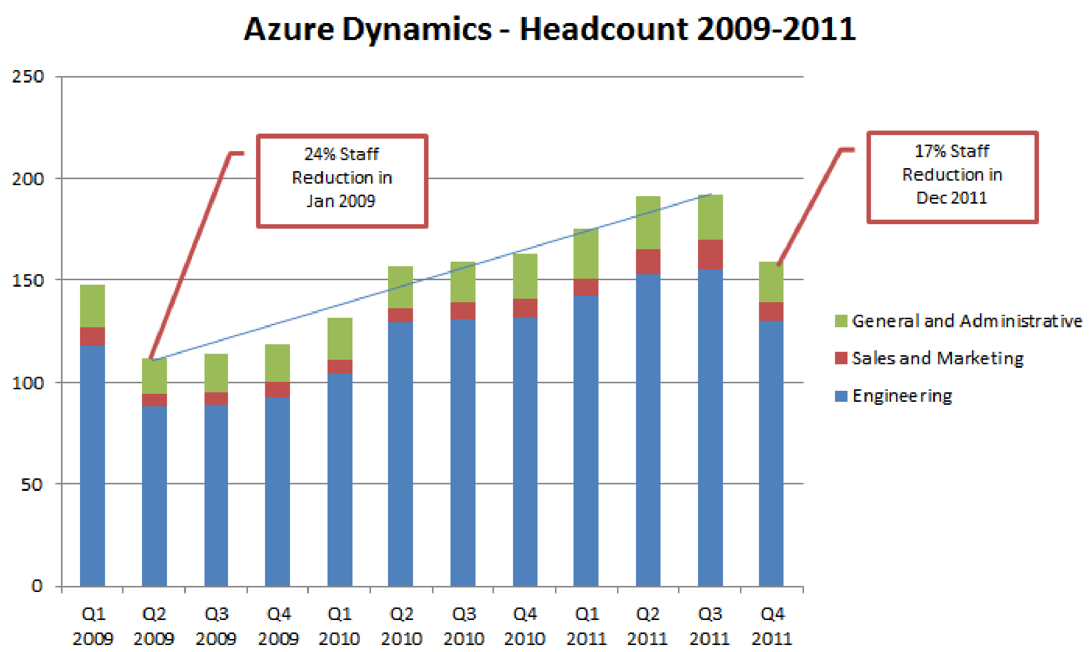


Figure 43 - Azure Dynamics Headcount Expansion 2009-2011

5.3 Restructuring Efforts

After the failure of the November 2011 financing, Azure Dynamics began to consider alternative strategic options including a possible sale or investment in Azure Dynamics. With only enough operating capital for 6 months, Azure Dynamics management attempted to reduce expenses while they continued in earnest to try to find additional financing.

5.3.1 December 2011 Cutbacks and Austerity Measures

Following the challenging November 2011 share offering, in December 2011 Azure Dynamics acted immediately to implement austerity measures to reduce operating expenses. Austerity measures included:

- Laying off approximately 15% of the employees
- Eliminating RRSP benefits (Canadian office) and 401K contributed benefits (US offices)
- Reducing discretionary expenses and travel expenses, and
- Deferring new product development activities

The intent of these actions was to prolong the remaining working capital and liquidity for as long as possible while strategic options were explored.

5.3.2 Attempts to solicit interest from potential buyers or strategic partners

Following the failed November 2011 share offering, Azure's management hired Lazard Frères & Co to assist with the search in North America for prospective buyers or strategic investors in Azure Dynamics. Between November 2011 and March 2012, four companies engaged in discussions with Azure Dynamics to perform due diligence on Azure's books, but Azure became insolvent in March before a strategic transaction with any of this firms could be concluded.

In November 2011, Azure also hired consultants in China to focus on finding Chinese companies with both the financial ability to make a strategic investment in Azure and with an interest in the electric vehicle market in China. Meetings were held in China with prospective partners in November 2011, and representatives from three Chinese firms were scheduled to visit Azure's various operating locations throughout North America in March 2012. In a similar fashion to efforts in North America, Azure Dynamics became insolvent in March before the negotiations with potential Chinese investors could run their course to any sort of agreement.

5.3.3 Proposed February 2012 Offering

In February 2012, Azure filed a preliminary short form prospectus with the TSX for a proposed offering of units consisting of one Azure common share, one share purchase warrant and one share option. This offering was expected to close in early-to mid-March 2012, and Azure estimated that minimum net proceeds would have been $10.5 million, with additional possible net proceeds of $1.1 million if an over-allotment option granted to the agents was exercised. Azure management hoped that this offering would have enhanced Azure's liquidity and would have given Azure sufficient runway to continue as a going concern for the next six months, and would have allowed the sales solicitation process to come to fruition.

However, the closing of the February 2011 share offering was subject to approval by the TSX exchange and the Ontario Securities Commission (OSC). Because of concerns over dilution and concerns over liquidity, the OSC required Azure to include in its final prospectus detailed cash flow forecasts for the twelve-month period following closing of the February Offering. Azure was prepared to disclose the cash flow forecast information and all relevant risks in the February prospectus. However, the OSC refused to receive the final prospectus.

Because of the OSC's refusal to receive Azure's February prospectus, Azure's board of directors only option was to abandon the offering and commence CCAA bankruptcy proceedings in an attempt to preserve Azure's enterprise value while pursuing restructuring options.

5.3.4 Restructuring During CCAA Proceedings

After the approval of the CCAA filing for bankruptcy protection in the BC Supreme Court on March 26th, 2011, Azure announced a layoff of 120 of their existing 161 employees including all staff in Boston, Detroit, the UK, and 50% of the Vancouver staff. The Boston, Detroit and UK facilities were all closed and Azure retrenched all engineering services operations to its operational hub in Vancouver. All outsourced manufacturing operations of the Transit Connect Electric van platform and the Balance Hybrid Electric truck platform ceased. Azure's CEO, COO, and CFO in Detroit resigned, and the only remaining staff consisted of a group of approximately 25 of the Vancouver employees and two Detroit executive officers. Azure's board of directors handed over interim management responsibility to the CTO, VP of Finance, and VP of Product Development in Vancouver, and the VP of Marketing and the VP of Product Engineering in Detroit.

As part of the CCAA process, the BC Supreme Court appointed the firm Ernst & Young as the Monitor of the restructuring process. Azure has obtained two months of interim Debtor-In-Place (DIP) financing to provide breathing room while remaining Azure executives continued discussions with potential suitors as part of the Sales or Investment Solicitation Process (SISP). Azure continues to seek alternative investors or acquirers of the engineering services and related technology

6 Strategic Fit Assessment for Azure Dynamics

The internal analysis continues by using Porter's generic strategy model (Porter, 1998a) to look at potential strategies that can be employed to derive competitive advantage from Azure's resources and capabilities. The analysis first looks at Azure's generic strategy with respect to how Azure positions itself in the market, identifies customer needs within chosen segments, and demonstrates its value proposition and competitive advantages. The chapter then provides a strategic fit assessment that looks at whether certain aspects and attributes of Azure's business model are consistent or not with Azure's strategy of Differentiation Focus. This analysis uses Bukszar's strategic fit model (Bukszar, 2009).

6.1 Azure Dynamics' Generic Strategy – Differentiation Focus

According to the approach developed by Michael Porter in his seminal book "Competitive Advantage", there are 3 generic strategies which are commonly used by firms to maintain competitive advantage and achieve above-average performance: a Cost Leadership strategy, a Differentiation strategy and a Segmentation (or Focus) strategy (Porter, 1998b). Within a Segmentation generic strategy, there are two sub-categories: Cost Focus, and Differentiation Focus. These are illustrated in Figure 44.

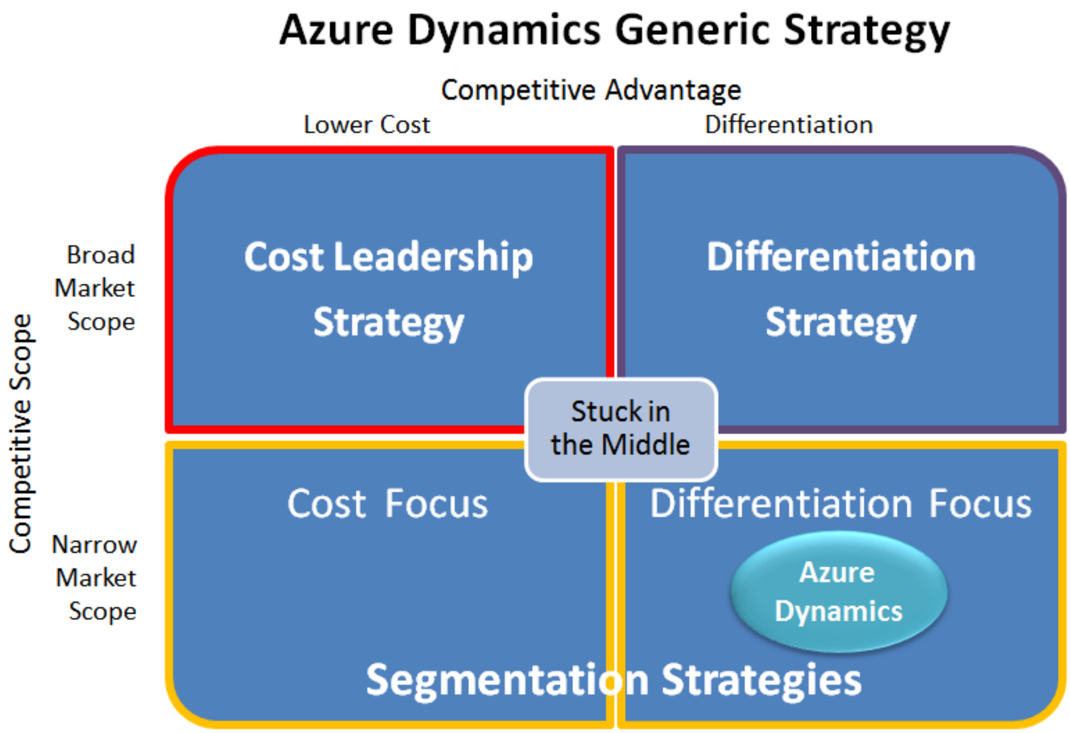


Figure 44 - Azure Dynamics Generic Strategy

Azure Dynamics is pursuing a Differentiation Focus generic strategy, in which it focuses on the light-duty commercial vehicle (LCV) market segment (class 1-2 of the truck industry) for its Transit Connect Electric full battery-electric vehicles (BEV), and the medium-duty commercial vehicle (MCV) market segment (class 2c-5 of the truck industry) for its Balance hybrid electric vehicles (HEV). Azure's competition was discussed previously in section 3.1. Within these segments, Azure targets those fleet customers that spend 50% or more of their operating expenses on fuel. Commercial trucks in the LCV and MCV classes have high rates of utilization and typically only stop for long periods at night. In the daytime, these vehicles have a fairly routine duty cycle where vehicles are dispatched on the same well-travelled routine routes every day. Ideal fleet customers have vehicles which typically start and stop several hundred times throughout the day and have high idle times.

Azure's "40/30/30" value proposition is:

1. To offer up to a 40% improvement in fuel economy
2. Provide a 30% savings on maintenance costs,
3. Reduce greenhouse gas (GHG) emissions by 30%.

For vehicles with conventional ICE power plants, the fuel, operating and environmental costs are much higher due to the inefficiencies of the ICE engine and a high emissions profile. Azure creates value for these fleet customers by providing cost-effective powertrain systems that adopt smart energy management algorithms. A design approach called "right-sizing" also allows Azure Dynamics to select much smaller powertrain components than would otherwise be required. These powertrains are more efficient than competing powertrains while meeting the same performance criteria.

By adopting a Differentiation Focus strategy, Azure also strives for greater customer intimacy to understand a fleet manager's needs. Azure's sales team uses demonstrations and field trials to demonstrate the 40/30/30 value proposition with prospective customers. Most of these prospects have already investigated hybrid technology and are predisposed to acquiring clean fleet vehicles - if the price is advantageous. Azure sales team seeks customer input on performance specifications early in the product development lifecycle.

6.2 Strategic Fit of Business Model with Generic Strategy

The internal analysis concludes here by looking at whether certain attributes of Azure's business model are consistent or not with Azure's strategy of Differentiation Focus. This analysis uses Bukszar's strategic fit model (Bukszar, 2009). The Strategic Fit assessment scorecard shown in Figure 45 shows a continuum between cost-based strategies on the left end, and differentiation strategies on the right end. For each attribute category, a strategic fit rating is provided out of 10 points. For a differentiation strategy, a score of one is a poor fit and 10 is a perfect fit. Conversely, for a cost-based strategy, a score of one is a perfect fit and a 10 is a poor fit. Azure uses a Segmentation Strategy with a Differentiation Focus. For this assessment, a Differentiation Focus strategy is similar to a Differentiation Strategy but with a narrow market scope. A separate score rating is made on the continuum for each of nine attributes. These attributes provide a reasonable categorization of organizational capabilities that support strategy.

Azure Dynamics Strategic Fit Assessment

Category	Cost Based Strategy Low Cost / Adequate Quality	Score 1	2	3	4	5	6	7	8	9	10	Differentiation Strategy High Quality / Adequate Cost
Product Strategy	Rapid Follower									☆		Innovator
R&D Expenses	Low R&D										☆	High R&D
Structure	Centralized			☆								Decentralized
Decision Making	Low Autonomy			☆								Autonomy
Manufacturing	Economies of Scale	N/A - Manufacturing is outsourced										Economies of Scope / Flexible
Labour	Mass Production									☆		Highly Skilled / Flexible
Marketing	Comparitive Push									☆		High Cost Pioneering / Pull
Risk Profile	Low-Risk										☆	High-Risk
Capital Structure	Leveraged	☆										Conservative

Figure 45 - Azure Dynamics Strategic Fit Assessment- Source:(Bukszar, 2009)

This grid summarizes the degree of Strategic Fit between Azure's strategy and its resources and capabilities. Each of these attributes is discussed in detail below.

6.2.1 Product Strategy

Azure is following an innovator strategy in differentiating its powertrain product designs. As the first mover in the light-duty commercial vehicle (LCV) and medium-duty commercial vehicle (MCV) market segments for fleets, Azure estimates that it currently holds a 60% market share in these segments for HEVs, PHEVs and EVs in North America. Azure's vehicles have accumulated more than 35 million miles of real-world driving experience. Azure was one of the first companies authorized to provide EV, PHEV and HEV solutions using Ford's light-duty and medium-duty commercial vehicles. Azure's technology has made the Ford Transit Connect Electric the only pure EV van currently available on the US light-duty LCV market. Azure's Balance P1 hybrid-electric van was the first hybrid van based on the Ford's E-450 series chassis in the US medium-duty MCV market. Azure is continuing this innovation with the development of a PHEV solution for the Ford Super-Duty F-450/F-550 truck chassis platform.

6.2.2 R&D Expenses

Up until 2009, Azure was an early-stage development company that had no yet started to generate significant revenues from the commercialization of their hybrid-electric and electric vehicle technologies. Consequently, Azure R&D expenditures exceeded corporate revenue until 2010. To this day, Azure still depends entirely on share offerings and equity financing to meet operating expenses because gross margins are still negligible (Figure 46).

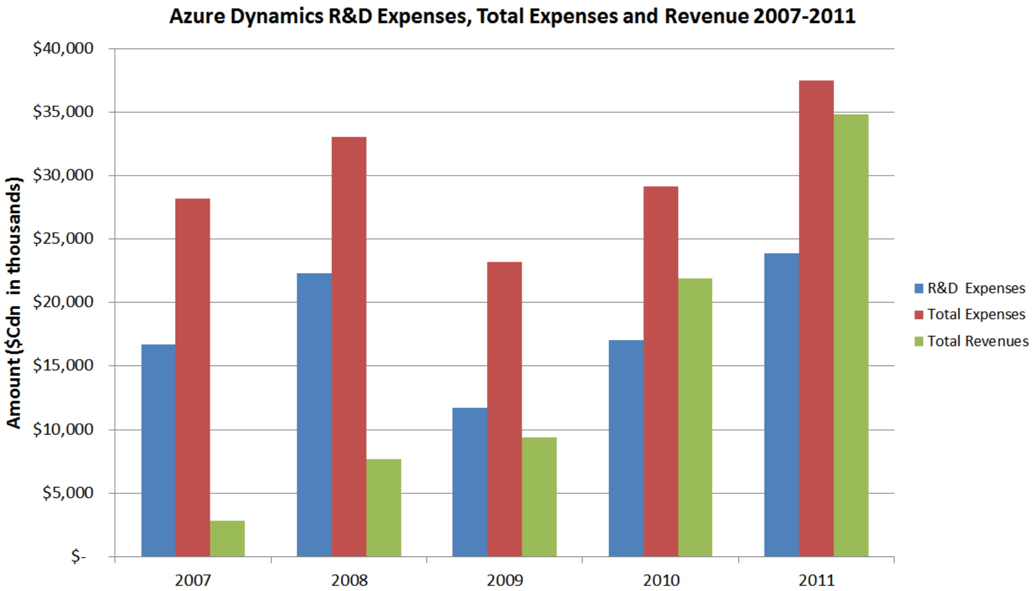


Figure 46 - Azure Dynamics R&D Expenses, Total Expenses and Revenue 2007-2011

With the change to commercialization of products in 2009-2012, Azure's revenues exceeded R&D spending for the first time, but Azure is yet to turn the corner and become cash-flow positive such that the gross margins from sales exceed the total corporate operating expenses. Azure spends Azure typically spends about 50% to 67% of total expenses on the engineering R&D budget, and for 2010-2011 Azure spent 78% and 69% respectively on R&D as a % of Revenue (Table 28).

R&D Spending	**2007**	**2008**	**2009**	**2010**	**2011**
R&D Expenses	$16,690	$22,286	$11,681	$17,028	$23,897
Sales and Marketing Expenses	$3,683	$3,418	$2,388	$2,784	$3,744
General & Admin. Expenses	$7,813	$7,314	$9,134	$9,329	$9,852
Total Expenses	$28,186	$33,018	$23,203	$29,141	$37,493
Total Revenues	$2,801	$7,651	$9,403	$21,913	$34,807
R&D spending as a % of Expenses	59%	67%	50%	58%	64%
R&D spending as a % of Revenues	596%	291%	124%	78%	69%

Table 28 - R&D Spending as a Percentage of Expenses and Revenue

At 69% to 78% of revenue, Azure's R&D expenditures are extremely high, even among powertrain firms with a differentiation or differentiation strategy. The primary reason that R&D expense are this high is that up-front vehicle development costs in the automotive industry are extremely capital expensive, and the auto industry relies heavily on building production volumes to recover the up-front product development costs. Azure is yet to develop any considerable sales volume. Azure estimates that cumulative vehicle sales will need to reach in excess of 100,000 vehicles before economies of scale will help to reduce the burden of fixed costs on the selling price of the vehicle. To maintain its position as the leader and innovator in the HEV and EV market, Azure needs to continue to invest in R&D. The strategic fit in R&D expenses is 10 out of 10.

6.2.3 Corporate Structure

Azure's has only one strategic business unit (SBU) which uses a functional and hierarchical corporate organizational structure. The diagram in Figure 32 from the Human Resources section 4.2.8 provides a summary of the organization chart. For Azure's segmentation (niche or focus) strategy, a single business unit (SBU) structure is a good fit. Both of Azure's hybrid-electric (HEV) and all-electric (BEV) product lines have a high degree of overlap, since they share similar components including batteries, electric motors, power inverters, and electronics and highly-related designs for the control software. Both HEV and BEV product lines also share outsourced manufacturing and distribution strategies, and share trucking and fleet customers with comparable application requirements (e.g. service, delivery, logistics, and postal applications). Within this functional structure, each of Azure's facilities (Burnaby, Woburn, Detroit, and Stevenage) has a specific role. The Woburn centre near Boston focuses on the design and production of ForceDrive power inverters, electric drives, and electronic components. The Burnaby BC office focuses on controls software development, systems engineering and vehicle integration. The Oak Park headquarters office near Detroit focuses on corporate management, sales and marketing, field application engineering and manufacturing engineering. The Stevenage office in the UK is headquarters for the European sales and distribution channels. Although the facilities and roles are physically distributed, the reporting structure is centralized to some extent. The strategic fit is 3 out of 10 (a more centralized reporting structure). This centralized organization structure would be inconsistent with a differentiation strategy if there were multiple SBUs, each responsible for its own market segment, but it is entirely consistent with a segmentation strategy (differentiation sub-type) with a single SBU focused on a small niche segment of the market.

6.2.4 Decision Making

Since Azure has a single strategic business unit (SBU) with a centralized hierarchical reporting structure, the decision-making is also less autonomous. The component design, systems engineering design, vehicle integration, supply chain, manufacturing, and sales and marketing strategies all have to be aligned for both HEV and EV product lines. Most significant decisions relating to program strategy, product roadmaps, spending budgets, and human resource requirements are made in the Detroit office at the C-level executive level. Most strategic issues and sales targets are decided at the executive level as well. Product planning requires a fair degree of coordination between the three product development offices. Although VPs and mid-level managers within their functional departments have limited control over what the overall program objectives should be, they do have a fair degree of autonomy within their teams with regard to how to implement those objectives. Strategic fit is 3 out of 10.

6.2.5 Manufacturing

Since manufacturing is outsourced, this attribute of the strategic fit has not been rated (N/A). For each product line, Azure is free to choose an outsourced upfitter supplier who is focused either on a minimal cost strategy or on economies of scope (flexibility).

6.2.6 Labour

Since manufacturing activities are outsourced, the remaining Azure Dynamics staff members (who work on primary activities such as inbound/outbound logistics, manufacturing, and product service) are dedicated to supporting small-volume prototype vehicle assembly (pre-production prototypes and field trial vehicles). The labour force in this area is highly skilled, extremely flexible and capable of supporting a varied mix of prototypes within the shops and service bays.

For secondary activities such as engineering R&D, supply chain management, and manufacturing engineering, Azure benefits from a highly skilled and flexible team, but with somewhat limited size and resources. Typically, due to the breadth of the various commercial truck markets, there are not enough resources to develop products simultaneously for all market segments or customer opportunities. Thus, the new product development managers have to prioritize on the most-economic product programs and leave other programs or markets vulnerable. The strategic fit for the labour category is 9 out of 10.

6.2.7 Marketing

Azure relies heavily on the Ford dealer network for distribution for smaller accounts, and has a small direct sales team that focuses only on large national accounts from the top 100 largest fleets. With the Ford distributors and dealers, Azure provides marketing collateral and material to promote the products.

Azure has typically already identified targeted large fleet accounts, and uses a pull strategy to help influence those accounts by advertising in trucking fleet industry publications, trade shows (e.g. NTEA Work Truck Show in Indianapolis, North American International Auto Show in Detroit, HTUF – hybrid truck user forum) and direct mailing. The Azure marketing team creates white papers, press releases, backgrounders and investor releases that build value and position the company. It also schedules interviews, and speaking opportunities at alternative transportation conferences.

The communications strategy for advertising to fleet customers uses the tag line "Azure – Driving a World of Difference" to showcase AZD's 40/30/30 product value proposition. The strategic fit for the pull strategy is 9 out of 10.

6.2.8 Risk Profile

Azure has a high-risk profile that is consistent with a differentiation focus strategy. The biggest risk elements are macro-economic factors that might affect market adoption for commercial HEV and BEV trucks and erode the 40/30/30 value proposition that Azure uses to attract customers ("40% fuel cost savings, 30% maintenance cost savings, and a 30% greenhouse gas emissions reduction").

Specific macro-externalities that may jeopardize the adoption of HEV and EV technology in LCV and MCV market segments, and Azure's value proposition within those segments include:

- Weak global economic conditions (particularly in Europe) continue to impact demand in the ailing automotive industry

- Improvements in the fuel economy of the internal combustion engine (e.g. Isuzu/Utilimaster Reach CV-23 truck reduce the relative savings in fuel economy of Azure's Balance truck)
- Improvements in the economies of scale for lithium-ion battery production may occur more slowly than anticipated, and corresponding reductions in the cost of batteries may not happen
- World oil prices may not rise as quickly as needed to provide sufficient fuel economy savings to achieve a quick payback for the fleet customer
- Risk of change in government stimulus programs (tax subsidies, rebates) and environmental policies that promote fuel efficiency and adoption of alternate forms of energy

A Differentiation Focus strategy is consistent with the high risks that Azure must take to develop HEV and BEV products that differentiate it from competitors. The strategic fit is 10 out of 10.

6.2.9 Capital Structure

As mentioned in the Azure Dynamics Financial History in section 5.1, Azure transitioned from a state of reasonable solvency and a low debt-to-equity ratio of 0.15 in 2007, to being leveraged with a high D/E ratio of 2.2 in 2011. More recently, Azure Dynamics has financed its transition to production and its expansion to sales in Europe through growing debt. However, it is the erosion of the equity value of the company (because of the growth in the deficit) that is mainly responsible for the growth in the D/E ratio.

This heavily leveraged capital structure makes Azure particularly vulnerable to the higher risks of a differentiation focus strategy and is relatively poor strategic fit. The score is 1 out of 10.

6.3 Overall Assessment of Fit

The biggest problem with Azure's strategic fit is the inconsistency of the capital structure. Azure employs a high-risk Differentiation Focus strategy which requires very high level of R&D spending and which typically requires high sales volumes at low margins to offset high up-front development costs. However, Azure is excessively leveraged and has too much of a debt burden for a company that is taking such costly risks to differentiate its products.

The most glaring issue of Azure's strategy is the excessive reliance on equity financing and share offerings to finance the operating budget. Typically, once successful firms have already successfully launched and commercialized products, the proceeds of equity financing and share offerings are used in a more appropriate fashion to support the capital spending for growth initiatives rather than covering operating expenses that normally should be covered by gross margins on sales (i.e. internal cash flow from operations).

The ultimate survival of Azure is jeopardized by the unsustainable policy of using equity financing to cover substantial net operating losses. The only way Azure can mitigate this problem is to achieve positive gross margins by:

- Increasing sales volume by reducing the costs of its proprietary components and reducing bill of materials costs of its products to achieve higher margins
- Increasing unit sales of its existing products by improving the value proposition to fleet customers (decreasing the customer payback period to recover the higher incremental costs of its electric and hybrid vehicles over conventional vehicles)
- Developing and launching additional product lines that leverage and capitalize on its existing ForceDrive component technologies while only incurring capital investment at the systems engineering and vehicle integration level
- Lowering maintenance and service costs that offset the higher initial purchase price of electric vehicles compared to conventional vehicles

Azure Dynamics will not be able to reach profitability merely by reducing product costs to improve margins if the company does not also attain an adequate sales volume to cover operating expenses.

7 Analysis of Strategic Alternatives

This chapter performs an assessment of Azure's situation (assuming the pre-insolvency scenario as of 1st quarter 2011) and extrapolates Azure's performance as it remains on the status quo path leading up to the insolvency and afterwards. While examining Azure's 2011 status quo strategy, there is always the potential for a hindsight bias: the tendency to see the insolvency events that have already occurred in the past as being more obvious and predictable now than they were at the time in early 2011. This analysis reviews the strategy based on the information that was available at the time in early 2011 to Azure management. A fulcrum analysis method (Boardman, Shapiro, & Vining, 2003) is used to compare the results of the external and internal analyses, and then assesses whether it makes sense to continue with the status quo business strategy. Several potential alternative strategy scenarios are presented, which represent choices to improve Azure's overall performance. These strategic options are evaluated using a Balanced Scorecard Model (Kaplan & Norton, 1996) that looks at Azure's performance from several perspectives:

- **Financial Perspective**: Use relevant financial metrics and key process indicators (KPIs) that are important to Azure's shareholders (revenue growth, gross margins, ROI, and profitability) to evaluate the tangible outcomes of the strategy option.
- **Customer Perspective**: For each option, determine the strategy's alignment with the customer's value proposition using suitable criteria such as Total Cost of Ownership, Time to Payback (recover incremental costs), Vehicle Range, and Fleet Uptime.
- **Internal Business Perspective**: Distinguish metrics for each strategic option (e.g. Ratio of Material Costs to Standard Cost, Order Fulfilment Time, Warranty Cost Per Vehicle) to assess the effectiveness of Azure's internal business processes and activities that are necessary to succeed in creating the desired outcomes
- **Learning and Growth Perspective**: Assess how intangible assets such as human resources, information systems, and organizational culture contribute to the

effectiveness of value-creating internal processes. Use KPIs such as Meeting schedule targets, Time to Market for New Products, and Sales Forecast Accuracy.

Key success factors for the commercial vehicle industry segments where Azure Dynamics participates were described in section 3.3, and Azure's performance challenges were reviewed in section 5.

7.1 LCV and MCV Market Segment Attractiveness & Azure Dynamics' Competitive Position

From section 3.2 (which reviewed the Porter 5-Forces Analysis of the North American and European Commercial Electric Vehicle Market), the overall average rating in the long-term of the LCV market segment was 3.32 / 5 indicating that the strength of threats or forces was medium. In addition, the overall average rating of the MCV market segment was 3.47 indicating that the strength of threats was medium-high.

However, in section 3 (which addressed the Attractiveness of the Commercial Electric Vehicle Industry) the overall attractiveness of the LCV and MCV market segments was slightly lowered or reduced because of significant industry hurdles in the short term. Specifically, there is a slower than expected adoption of EVs, and exogenous factors affecting the world economy (including the sovereign debt crisis in Europe). The fleet customer's value proposition continues to be affected by extremely high initial capital outlay (primarily from high Li-Ion battery prices). These factors leave the hybrid-electric and all-electric vehicle markets more vulnerable to the threat of substitutes (particularly from ICE vehicles) in the short term. The attractiveness rating given to the LCV market segment was low to medium, and the MCV segment was low.

Azure Dynamics competitive positions in the LCV and MCV markets are currently weak because of cost factors. As section 5.1 in the financial performance chapter demonstrated, Azure has so far been unable to overcome issues related to excessively low product gross margins. The overall strategic fit in section 6.3 also demonstrated that Azure's capital structure was a huge risk item. Ultimately, the survival of Azure is jeopardized by the constant need to raise cash from equity financings to cover operating losses. The operating losses are directly related to the problems with skimpy gross margins. Assuming that Azure can address the product cost issues, then the desired competitive positions in the LCV and MCV markets should improve to Medium and Strong respectively. On the other hand, if the cost structure problems persist, then the expected or most likely outcome is for the competitive position to remain weak. LCV and MCV market attractiveness is plotted against Azure's competitive position in Figure 47 and Figure 48 respectively. The CS, DS and ES bubbles on the charts correspond to the current states, the desired future states and expected states. Even though the markets will become increasingly attractive, it is possible that if Azure continues on its current path with low gross margins that Azure's competitive position will deteriorate.

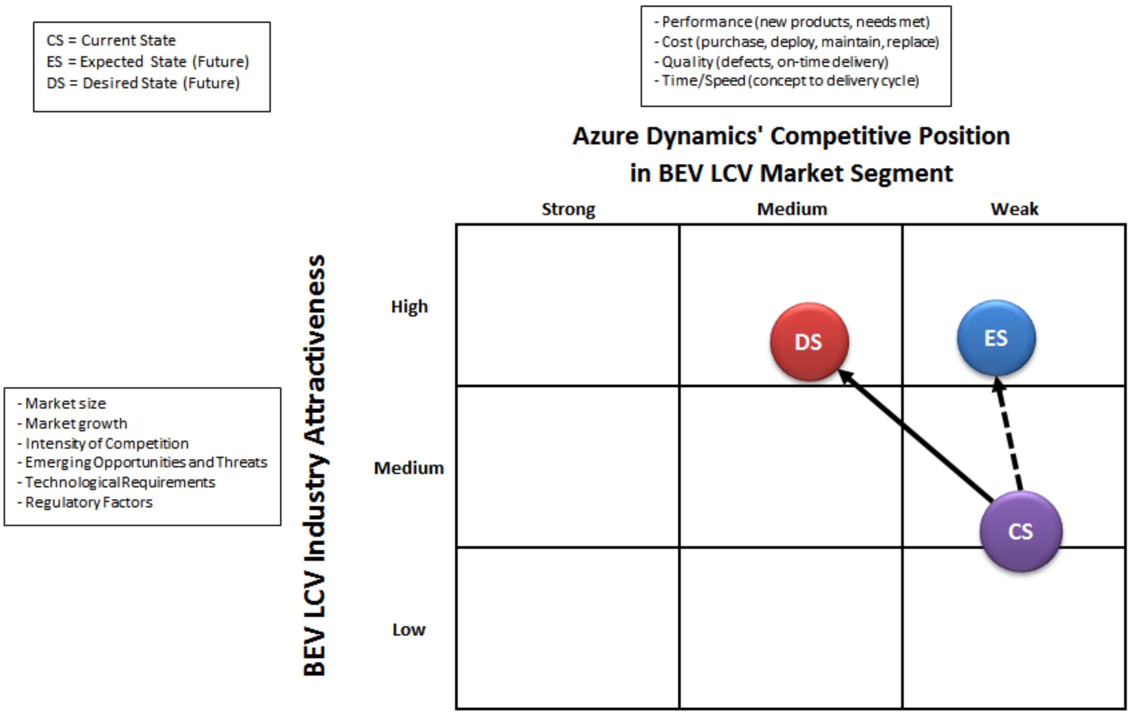


Figure 47 - Performance Assessment - Light-Duty BEV Market Segment

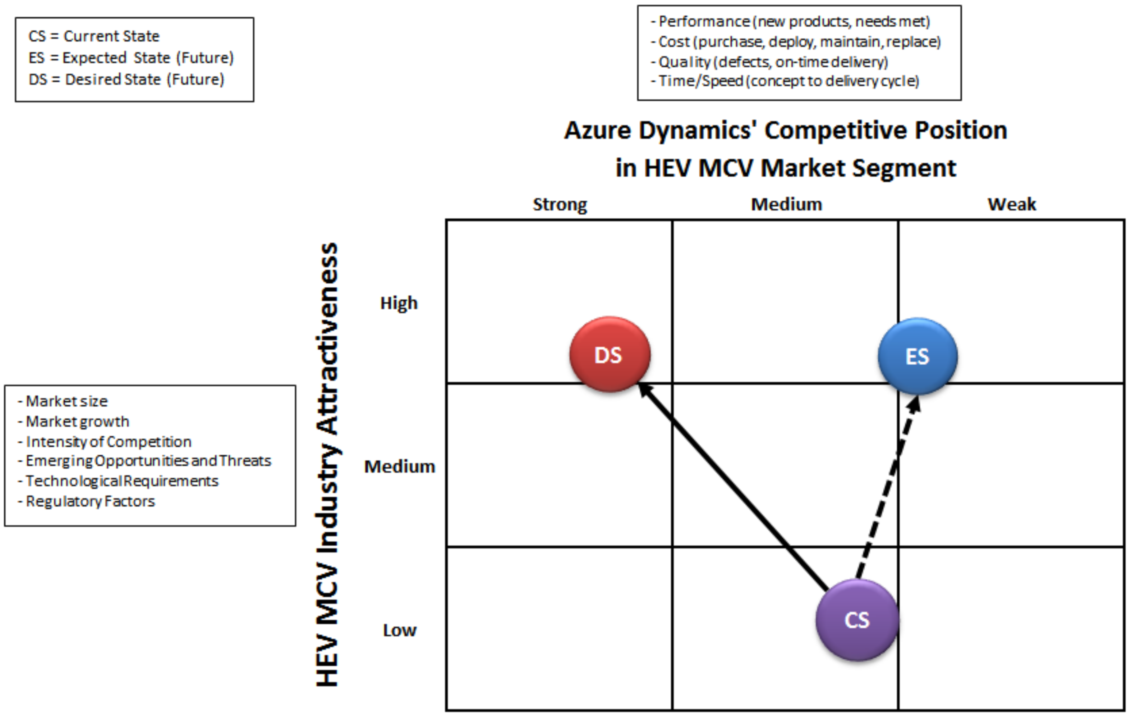


Figure 48 - Performance Assessment - Medium-Duty HEV Market Segment

7.2 Strategic Options

This section analyses alternative strategic options for Azure Dynamics both pre-insolvency and post-insolvency. From the industry analysis in chapter 2 and the internal analysis in chapter 3, 7 scenarios were developed that can help Azure achieve its goals. These scenarios are summarized in Table 29 and are followed by a detailed description of each option.

Pre-Insolvency Scenarios						
				Post-Insolvency Scenarios		
Scenario A **Status Quo**	**Scenario B** **Expand to China with Joint Venture**	**Scenario C** **Invest in PHEV utility truck platform**	**Scenario D** **Invest in BEV full-size cargo van platform**	**Scenario E** **Become ForceDrive Component Supplier Exit Vehicle Products Industry**	**Scenario F** **Sell Firm as a Going Concern**	**Scenario G** **Liquidation**
Continue in LCV and MCV markets with cost-reduced Balance and Transit Connect Electric products aiming to improve sales and market share	Similar products and segments as scenario A but sign joint venture to expand geographic scope to China	Developer new PHEV Boom/Bucket Truck based on Ford F-550 SuperDuty platform to be used for telecom and utility applications in Class 5-6 MCV market segment.	Develop new all-electric BEV van based on full-size Ford Transit platform to address service and cargo delivery applications for Class 2-3 LCV market segment.	Leave the sales of fully integrated BEV and HEV truck products entirely. Focus on sales of EV Components to OEMs, and offering engineering services as control systems integration consultants	Similar to Scenario B but the restructuring process involves an outright sale of the firm as a going concern to Chinese auto parts supplier instead of using a joint venture.	Azure ceases to operate as a going concern. All employees are laid off, and all IP and tangible assets are divested.

Table 29 - Summary of Scenario Options for Azure Dynamics

7.2.1 Scenario A - Status Quo

This strategic option implies that Azure would continue to sell both the Ford Transit Connect BEV van in the light-duty LCV market and the Balance HEV delivery truck in the medium duty MCV market. The focus of investment in this strategy would be on cost-reduction of these existing products with the aim of improving product margins, improving sales and market share, and generating enough internal cash flow to cover operating expenses and move towards profitability.

7.2.2 Scenario B - Expand to China with Joint Venture

This scenario is somewhat similar to scenario A since it involves continuing to sell the existing Transit Connect Electric and Balance product lines, and continuing to invest in the cost-reduction and on-going enhancement of those products. Where this scenario differs is that it involves an expansion in geographic scope - by adding China to the markets served by Azure.

There is considerable interest in China for adopting hybrid-electric and electric vehicle technology for application areas such as school buses. The Chinese government is also pushing the adoption of electric vehicle technology (particularly short haul logistics applications) for reduction of emissions in heavily polluted urban environments.

Under this scenario, Azure would sign a joint venture (JV) or strategic partnership transaction with a suitable Chinese automobile components manufacturer to create a mutually beneficial partnership. A Chinese firm would gain access to Azure's proven EV technology that would allow it to produce electric vehicles for the Chinese market. The joint venture operation in China could benefit from Azure's core competencies in its systems engineering and vehicle integration capability as well as access to Azure's designs and intellectual property. Azure would benefit from the deal by getting a substantial financial investment to cover operating expenses and by getting access to the Chinese market for its technology. China is the largest truck market in the world and Azure would benefit from the Chinese component manufacturing expertise and economies of scale that would drive down costs and improve Azure's gross margins. Azure would take advantage of the improvements in the cost structure to sales of its own products in North America and Europe. China also has the long-term vision and willingness to invest in the nascent EV industry that is critical for its survival.

Risks in the JV would include the challenge of hammering out a JV legal agreement. This activity would include the investment of a considerable amount of energy and time and would require obtaining Chinese government approval of the joint venture. Additional risks would include assurances that there were appropriate provisions to protect Azure Dynamics intellectual property in the uncertain legal environment in China.

7.2.3 Scenario C – Invest in new PHEV platform to address utility truck applications in MCV Segment

This scenario involves a significant investment in Azure's PHEV technology to integrate it into the Ford F-440 and F-550 SuperDuty truck models. This investment would facilitate the expansion of Azure's market share in the MCV market by adding a new PHEV Class 6 utility vehicle platform to be used for commercial applications such as utility service trucks, telecommunication trucks, shuttle buses and delivery vehicles. The platform would address the needs of utility and telecom firms companies in the MCV market segment.

Azure has the option to develop hybrid-electric powertrains for other Ford SuperDuty models under the partnership agreement that Azure signed with Ford in July 2011. The SuperDuty truck product line has more than 50% market share of the North American medium-duty market (Azure Dynamics, 2011).

For this strategic option, Azure would try to leverage existing HEV technology from the Azure Balance HEV platform (which is based on the Ford E-450 Series chassis) by applying its knowledge to the Super Duty platform.

The size of the investment in developing a new PHEV powertrain system, including enhanced ForceDrive power inverter components and designing prototype vehicle systems for this project is expected to be considerable – approximately $10 million total to complete a prototyping phase by mid-2013. Once prototyping of the F-Series Super Duty PHEV is complete, Azure anticipates that it work with an upfitter partner on pre-production in early 2014, and move into final vehicle production and product support in mid-2014.

7.2.4 Scenario D – Invest in a new BEV full-size van platform to address service and delivery applications in LCV segment

As in scenario C, this scenario also involves a significant investment in Azure's technology to increase the number of customers serves in existing market segments. Specifically, Azure would develop improved all-electric BEV technology and integrate this powertrain into a full size van (similar to the new Ford full-size T-Series Transit van that will replace the legacy Ford E-Series Econoline van platform in 2013).

For this strategic option, Azure would expect to leverage existing all-electric BEV powertrain technology from the Transit Connect Electric vehicle platform (including electric drive components, control systems and battery components) and apply it to the electric vehicle design on the larger Class 2 cargo van platform. Note: the smaller Class 1 Ford Transit Connect vehicle that was introduced in 2010 to the US is mechanically unrelated to Ford's Class 2 full-size Ford Transit T-Series van platform.

Azure expects that this full size electric cargo van will offer fleet customers all the same benefits of its existing zero-emissions BEV technology (lower fuel and maintenance costs) compared to vans with conventional ICE powertrains, but will offer greater payload capacity, cargo volume and electric range than its existing Transit Connect Electric platform.

As with scenario C, the size of the investment in developing a new BEV powertrain system for a Class-2 full-size van (including enhanced ForceDrive power inverter components and designing prototype vehicle systems) would be a considerable undertaking.

7.2.5 Scenario E - Exit Vehicle Products Industry - Focus on ForceDrive Components and Services

This scenario options involves Azure Dynamics divesting itself of the selling of commercial BEV and HEV vehicles entirely (i.e. relinquishing the vehicle integration role) to focus instead on expanding its role as a hybrid-electric vehicle and all-electric vehicle component developer to supply other OEM vehicle manufacturers. This scenario also anticipates the Azure would also offer its expertise in power electronics and control systems software as electric vehicle engineering consultants.

It should be noted that this scenario could be considered as a potential strategic option both at the pre-insolvency stage and post-insolvency stage based on the knowledge available at the respective times to Azure management. For this analysis, we consider January 2011 as the approximate decision date for pre-insolvency strategic options, and March 2012 as the decision date for strategic options post-insolvency.

By divesting itself of the vehicle integration stage of production, this strategy is effectively the opposite of vertical integration. In its new role further up the value chain as a component supplier (essentially the same stage in the value chain as Azure's Boston components division acquired from predecessor Solectria), Azure would effectively mitigate the impact of high battery costs on the total bill of materials cost for the vehicle. Azure would offload this risk downstream to a large OEM truck manufacturer (e.g. Ford, Daimler, Volvo, Nissan, etc.) who has greater economies of scale and greater access to lithium-ion batteries at much lower cost than Azure Dynamics.

Another advantage of this change in positioning is the elimination of upfront capital costs needed to develop a new vehicle platform. Developing new powertrain component technology is a fraction of the cost of developing a new vehicle platform, primarily because it does not include the significant costs of vehicle prototyping, environmental testing, safety testing and field trials. However, there would need to be further investment in manufacturing capacity to be able to scale production of electric vehicle components to tens of thousands or even hundreds of thousands of drivetrains per year (to meet demand from large OEMs). In order to support the scalability of production, there may be certain advantages to collaborating with Tier 1 component suppliers that have excess manufacturing capacity.

For Azure to have a strong position as a powertrain component supplier, it would also have to strengthen its intellectual property (IP) position to provide a competitive advantage or differentiator for its electric vehicle powertrains. If Azure's IP position in circuit design and control software is too weak, then the competitive positioning of its electric drive components also will be weak. Azure would be more vulnerable to other competitors coming into the electric vehicle market to sell powertrain sub-systems and assemblies.

A critical aspect of this strategic option is finding a vehicle manufacturer or OEM who would want to acquire Azure's Transit Connect Electric and Balance vehicle designs and vehicle integration expertise. This firm also would have the potential to become a new customer of Azure Dynamics powertrain components. Potential candidates for assuming Azure's designs would be body builders or upfitters, or perhaps truck specialists. Potential candidates in North America might be firms such as Smith Electric Vehicles, VIA Trucks, Odyne trucks, Freightliner Custom Chassis, Morgan Olson or Utilimaster.

7.2.6 Scenario F - Sell Firm as a Going Concern

This scenario is similar to Scenario B but the process would involve an outright sale of the Azure Dynamics firm. It would be sold as a going concern (possibly to a Chinese auto parts supplier) instead of just signing a joint venture or strategic alliance deal.

As in Scenario E, this scenario could be considered as a potential strategic option that is relevant both at Azure's pre-insolvency stage and at the post-insolvency stage based on the knowledge available at the time to Azure management.

For the pre-insolvency stage as of January 2011, the critical aspect of any decision to sell Azure Dynamics would be the recognition that Azure's business model (which relied on the repeated usage of upfront equity financing or "future cash flows" to cover significant operating costs) was unsustainable in the longer term. Arguably, Azure had an excellent track record of locating investors willing to subscribe for equity financings and share offerings in the past, despite the firm's tarnished financial history of operating losses. Since it had never been a problem in the past, one could argue that there was no reason to believe that it would be any different this time around. However, there is a limit to how often this works and a firm can only "go to the well" a few times. In hindsight (as of the summer of 2012), this situation should be obvious. In January 2011 however, there was no signal of a looming economic crisis in Europe that would result in a tightening of the availability of capital on equity markets. Nevertheless, common sense would dictate that a repeated attempt to raise large sums on the TSX market (or the contemplated listing on the NASDAQ exchange) was an increasingly risky proposition.

Ultimately, this option assumes that Azure management realized that it needed to solve the gross margin problem (and become cash flow positive in a hurry) or sell the firm. Assuming that the former approach (solving the cost structure) could not be solved quickly, Azure management needed to find a willing buyer who could invest for the long term (i.e. absorb operating losses in the short term while solving issues with the cost structure to transition to a cash-flow positive condition).

7.2.7 Scenario G – Liquidation

This strategic option is only relevant at the time of post-insolvency. It does not make much sense to consider liquidation of a firm's assets until after a firm has become insolvent, since prior to insolvency, almost all other restructuring options for a company in crisis or distress will provide greater value to shareholders and creditors.

In the liquidation scenario, Azure as a corporate entity ceases to operate as a going concern. All employees are laid off, and all IP and tangible assets are divested, usually via a bidding process or asset auction managed by a third party receivership management firm or auction house. Although liquidation is an option worth considering as a way to minimize further losses, the pros and cons of liquidation are beyond the scope of this thesis. If Azure is liquidated and it exits the electric vehicle marketplace (either as a component supplier or as a vehicle integrator and supplier) then there is no need for a business strategy. The Balanced Scorecard evaluation criteria are irrelevant when the company is no longer a going concern, and all employees are terminated.

7.3 Strategic Option Balanced Scorecard Assessment

The objectives and measures in the Balanced Scorecard assessment evaluation have been defined using existing key process indicator (KPI) metrics used at Azure Dynamics with additions to the Financial Perspective and Customer Perspective objectives and measures to address perceived weaknesses and risks. The BSC scorecard results are divided into 2 parts in Figure 49 and Figure 50 respectively.

Note that the Financial Perspective has been given a high weighting factor due to the critical importance of improving gross margins and becoming cash flow positive as a matter of survival. Objectives and measures for financial risk including solvency and liquidity risk have been added. For the Customer Perspective, a high degree of emphasis has been given to improving the value proposition, reducing the total cost of ownership and reducing the payback time to recover the upfront incremental costs of purchasing Azure's HEV or EV trucks.

All of the scores for each attribute or measure in the balanced scorecard are in the range 1-5 where 1 is lowest and 5 ranks highest. The final total row contains the weighted average of the scores for each scenario.

7.4 Preferred Strategic Option

Table 30 contains a summary of BSC weighted average scores for the various strategic options:

Scenario	Weighted Average Score
Scenario A - Status Quo	**2.90**
Scenario B - Expand to China with Joint Venture	**3.86**
Scenario C - Invest in PHEV utility truck platform	**2.69**
Scenario D - Invest in BEV full-size cargo van platform	**2.69**
Scenario E - Become ForceDrive Component Supplier, Exit Vehicle Products Industry	**3.24**
Scenario F - Sell Firm as a Going Concern	**4.27**
Scenario G - Liquidation	**n/a**

Table 30 - Summary of Balanced Scorecard Results for Azure Dynamics Strategic Options

Of all of the alternative strategic options, the best fit and recommended strategy is Scenario F (Sell the Firm as a Going Concern). Scenario F had the highest score at 4.27 / 5 followed in second place by Scenario B – Expand to China with Joint Venture at 3.86 / 5. Both of these options are ranked higher simply because they involve an injection of badly needed working capital to ensure the survival of the company – perhaps long enough to give Azure Dynamics a chance to address the issues with cost structure and gross margins (which affect the need to use equity financing to fund operating costs). Note that Scenario C and D both perform poorly in this regard since the investment in new product development in these scenarios does nothing to address the need to address gross margin problems and to address the need to secure additional working capital. Azure needs to have enough cash or working capital to survive until it has addressed cost issues and until it can find new strategic investors. Scenarios C and D (which invest in product development) have good scores for the customer perspective (strong potential to increase market share and bring products to a new set of customers). However, this investment in products for the long term is irrelevant if these scenarios do nothing in the short term to address the financial liquidity and insolvency risks and weaknesses (i.e. problems with cash flow and gross margins).

Azure Dynamics - Evaluation of Strategic Options Using Balanced Scorecard (BSC)

					Pre-Insolvency Scenarios						
									Post-Insolvency Scenarios		
	Objectives	Measures	Targets	Weight %	Scenario A Status Quo	Scenario B Expand to China with JV	Scenario C Invest in PHEV utility truck platform	Scenario D Invest in BEV full-size cargo van platform	Scenario E Exit Vehicle Products Industry	Scenario F Sell Firm as a Going Concern	Scenario G Liquidation
Financial Perspective - 60%	F1 - Revenue Growth 20%	Sales Volume - Units Shipped		10.0%	2	4	3	3	3	5	-
		Revenue: Total Units Shipped x Selling Price		5.0%	2	4	3	3	1	5	-
		Number of New Customer Accounts Won		3.0%	2	5	4	4	3	5	-
		Improve Optimization of Selling Price		2.0%	4	4	4	4	2	4	-
	F2 - Improve Gross Margin 20%	Improve Gross Margin = (Revenue - COGS) / Revenue		10.0%	3	4	2	2	4	5	-
		Reduce component BOM costs to improve product margins		8.0%	3	4	2	2	4	5	-
		Reduce labour costs for manufacturing		1.0%	3	5	2	2	3	5	-
		Reduce fixed manufacturing costs		1.0%	3	3	3	3	2	3	-
	F3 - Reduce Expenses 10%	Meet Product Development Budget		5.0%	4	4	2	2	4	5	-
		Meet Cost Centre Budget		2.0%	4	4	2	2	5	3	-
		Inventory Management - Consolidated Inventory Turns		3.0%	2	4	3	3	4	5	-
	F4 - Reduce Risk 10%	Improve Solvency - increase Current Assets / Current Liabilities		5.0%	3	4	2	2	4	5	-
		Improve Liquidity - decrease Debt-to-Equity Ratio		5.0%	3	4	2	2	4	5	-
Customer Perspective - 20%	C1 - Value Proposition Lower Total Cost of Ownership 13%	Reduce Upfront Incremental Cost vs Conventional Vehicle		7.0%	3	4	2	2	4	3	-
		Improve Fuel Economy vs Conventional ICE Vehicle		2.0%	3	4	5	5	3	3	-
		Improve Maintenance Costs vs Conventional Vehicle		1.0%	3	4	4	4	3	3	-
		Reduce Time to Payback (Recover Incremental Cost)		3.0%	4	4	3	3	2	3	-
	C2 - Improve Product Performance 4%	Improve Vehicle Range for BEV, HEV and PHEV vehicles		1.0%	3	3	4	4	2	3	-
		Improve Vehicle Acceleration and Driveability		1.0%	3	3	3	3	3	3	-
		Improve Vehicle Safety		1.0%	3	3	3	3	3	3	-
		Improve Fleet Uptime (Reduce Charging Time)		1.0%	4	3	4	4	3	3	-
	C3 - Improve Customer Satisfaction 3%	Improve market share as measure of customer satisfaction		1.0%	2	4	4	4	1	5	-
		Improve On-Time Delivery		1.0%	3	4	3	3	3	4	-
		Improve Customer Retention		1.0%	3	3	3	3	3	3	-

Figure 49 - Evaluation of Azure Dynamics Strategic Options Using Balanced Scorecard (part 1 of 2)

					Pre-Insolvency Scenarios						
									Post-Insolvency Scenarios		
	Objectives	Measures	Targets	Weight %	Scenario A Status Quo	Scenario B Expand to China with JV	Scenario C Invest in PHEV utility truck platform	Scenario D Invest in BEV full-size cargo van platform	Scenario E Exit Vehicle Products Industry	Scenario F Sell Firm as a Going Concern	Scenario G Liquidation
Internal Perspective - 10%	I1 - Optimize operational costs 4%	Reduce Order Fulfilment Cycle Time		1.0%	2	4	3	3	3	5	-
		Reduce Logistics and Material Transportation Costs		1.0%	3	3	2	2	3	3	-
		Improve Material Cost against Standard Cost		1.0%	3	4	2	2	3	4	-
		Reduce Direct Labour Costs as % of sales		1.0%	2	4	2	2	3	4	-
	I2 - Improve design for manufacturing (DFM) 2%	Reduce number of components per product		1.0%	4	3	4	4	3	3	-
		Reduce setup time for cell		1.0%	3	3	3	3	3	3	-
	I3 - Improve Quality 3%	Reduce Defects Per Unit (DPU) = # issues / # of trucks		1.0%	4	3	4	4	2	4	-
		Reduce Warranty Cost per Vehicle (CPV)		1.0%	3	3	3	3	3	3	-
		Improve Supplier Quality (PPM) = Total Parts Rejected / Parts Received		1.0%	3	3	3	3	3	3	-
		Reduce Stock Outs = Number of Part Shortages per month		1.0%	3	4	3	3	3	4	-
Learning Perspective - 10%	L1 - Process Improvement 2%	Increase CMMI capability level		1.0%	3	3	3	3	3	4	-
		Improve Projects Completed on Time		0.5%	3	3	3	3	3	4	-
		Improve Projects Completed on Budget		0.5%	3	3	3	3	3	4	-
	L2 - NPD Innovation 3%	% of revenue from new products		1.0%	2	3	4	4	2	3	-
		Time to Market for New Products		1.0%	3	4	2	2	4	4	-
		Add New Core Competency		0.3%	2	3	4	4	2	3	-
		Improve investment in employee training		0.3%	3	3	4	4	2	3	-
		Number of Patents		0.3%	3	2	5	5	3	3	-
	L3 - Improve Business Model 5%	Improve sales forecasting accuracy		2.0%	3	3	3	3	3	3	-
		Increase number of channel partners / alliances / joint ventures		1.0%	3	5	3	3	3	5	-
		Reduce time to act on identified business opportunities		1.0%	3	3	3	3	2	4	-
		Increase number of new sales channels created per year		1.0%	3	4	2	2	2	3	-
	Weighted Scores (out of 5)			100.0%	**2.90**	**3.86**	**2.69**	**2.69**	**3.24**	**4.27**	-

Figure 50 - Evaluation of Azure Dynamics Strategic Options Using Balanced Scorecard (part 2 of 2)

8 Summary, Recommendations and Conclusions

The introduction identified that Azure Dynamics vision is "To be the world leader in providing hybrid-electric (HEV) and all-electric (BEV) powertrains and control systems for the light to medium duty commercial vehicle markets". To achieve this vision, Azure objectives must take advantage of strategic opportunities for growth including:

- Expansion of geographic scope
- Serving customers additional market segments, and
- Increasing market share within currently served market segments.

Azure's objectives must also address strategic weaknesses:

- Insufficient Working Capital
- Poor Gross Margins
- History of Operating Losses and Increasing Deficit
- Excessively High R & D Expenses Relative to Sales

The external analysis examined the nascent market for alternative powertrain technology (HEV, PHEV or BEV powertrains) in medium-duty commercial vehicle (MCV) and light-duty commercial vehicle (LCV) markets in North America and Europe where Azure enjoys an estimated 60% share of the market. The external analysis concluded that the level of attractiveness for the LCV and MCV segments of the commercial electric vehicle industry is **Low** for the short-term (in the next 5 years) and **Moderate to Good** in the longer term. Key success factors for the LCV and MCV markets for alternative powertrain technology include:

1. Finding Investors Long Term Commitment to Financial Support of Industry
2. Executing a Differentiation Focus or Niche Strategy (to mitigate the Threat of Substitutes from gasoline, diesel and CNG natural gas vehicles)
3. Mitigate the Battery Pricing Issue – either find lower cost battery suppliers or else factor out the impact of battery pricing through innovative battery leasing models
4. Focus on Key Contracts with Large Fleets

The internal analysis chapter identified Azure's core competencies including a proficiency in the development of strategic alliances, controls software design capability, power electronics design ability, systems engineering know-how and expertise in vehicle integration. Azure has excellent products and a reputation for high performance and quality with its fleet customers. Azure has been successful in growing revenue year-over-year since 2007 when it first transitioned from an early-stage research company to a company that is actively shipping commercial products. Azure has enviable strategic partnerships with Ford and Johnson Controls, which gives it access to technology (vehicle platforms, batteries) and Ford's dealer sales channels and distribution network.

However, Azure is in a distressed position from the perspective of an on-going record of operating losses, a loss of shareholder confidence and insufficient working capital to execute its product strategy (pre-insolvency) and in a crisis post-insolvency with considerable constraints in liquidity. Azure has a reasonable strategic fit with a Differentiation Focus strategy except for a poor fit for the capital structure. Azure's strategy relies excessively on equity financing and share offerings to finance the operating budget. A Differentiation Focus strategy requires high sales volumes at low margins to offset high up-front engineering development costs. Azure is excessively leveraged and has too much of a debt burden for a company that is taking such costly risks to differentiate its products.

The strategic option chapter concluded that the recommended strategic option is to pursue scenario F, which involves selling the Azure Dynamics firm as a going concern. The backup scenario, option B, would involve expansion to China by forming a Joint Venture with a Chinese firm. The advantage of both of these options is that they would inject badly needed working capital to ensure the survival of the company – perhaps long enough to allow the firm to address issues with the cost structure and gross margins (which affect the need to use equity financing to fund operating costs). The strategic alternative to sell Azure Dynamics as a going concern is a preferred option based on information that was available pre-insolvency as well as post-insolvency.

Appendices

Appendix A. Methodology

Market Segmentation Approach Used in Chapter 2.6

Various approaches for segmenting industrial markets to assess segment attractiveness have been proposed. This thesis adopts criteria from both *Principles of Marketing* (Kotler, Adam, Brown, & Armstrong, 2001) and *Segmenting the Industrial Market* (Bonoma & Shapiro, 1983).

According to Kotler's approach, the effectiveness of the segmentation depends on

- **Measurability** – whether the size and purchasing power of the segment is quantifiable
- **Accessibility** – The extent to which a marketing department can reach and serve a segment
- **Substantiality** – If a segment is large enough and profitable enough to justify a differentiated marketing strategy
- **Actionability** – Whether a marketing department can effectively devise a marketing strategy which appeals to customers in the specific segment
- **Differentiability** - The degree to which customers in each segment will respond differently to specific marketing incentives.

In the latter approach of Bonoma & Shapiro, segmentation is defined using a nested model. Some of the dimensions that can be nested are defined in Table 31.

Bases for Segmenting Industrial Markets
Demographic
1. Industry: Which industries should we serve?
2. Company size: What size companies should we serve?
3. Location: What geographical areas should we serve?
Operating Variables
4. Technology: What customer technologies should we focus on?
5. User or nonuser status: Should we serve heavy users, medium users, light users, or nonusers?
6. Customer capabilities: Should we serve customers needing many of few services?
Purchasing Approaches
7. Purchasing-function organization: Should we serve companies with highly centralized or decentralized purchasing organization?
8. Power structure: Should we serve companies that are engineering dominated, financially dominated, and so on?
9. Nature of existing relationship: Should we serve companies with which we have strong relationship or simply go after the most desirable companies?
10. General purchasing policies: Should we serve companies that prefer leasing? Service contract? Systems purchases? Sealed bidding?
11. Purchasing criteria: Should we serve companies that are seeking quality? Service? Price?
Situational Factors
12. Urgency: Should we serve companies that need quick and sudden delivery or service?
13. Specific application: Should we focus on certain application of our product rather than all applications?
14. Size of order: Should we focus on large or small orders?
Personal Characteristics
15. Buyer-seller Similarity: Should we serve companies whose people and values are similar to ours?
16. Attitude toward risk: Should we serve risk-taking or risk-avoiding customers?
17. Loyalty: Should we serve companies that show high loyalty to their suppliers?
Source: *Segmenting the Industrial Market* (Bonoma & Shapiro, 1983)

Table 31 - Bases for Segmenting Industrial Markets (Bonoma and Shapiro Model)

Value Proposition - Total Cost of Ownership (TCO) method for Chapter 2.7

The TCO for a vehicle is the sum of the initial capital cost of vehicle acquisition, and the costs of operating a vehicle over its entire service lifetime (including refuelling and maintenance costs) while subtracting the residual value of the vehicle and battery at the end of the ownership period. This is illustrated in Figure 51:

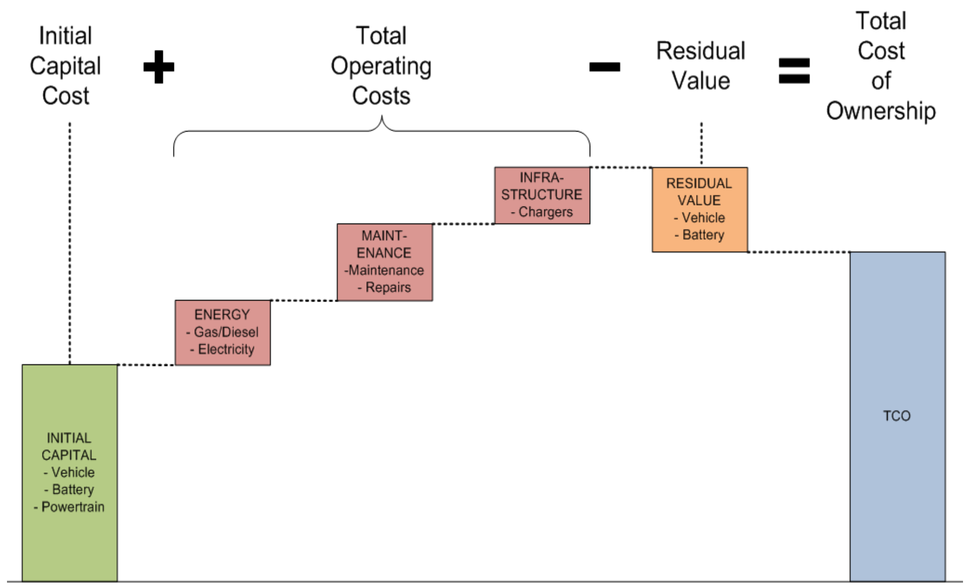


Figure 51 – Cost Components of Total Cost of Ownership (TCO)

Value Proposition - Payback Period method for Chapter 2.7

This approach to assess the customer value proposition determines the length of time it takes to recover the initial capital cost of purchasing new vehicles relative to some baseline capital budget (also known as "incremental cost"). The shorter the time it will take for payback (to recover the incremental costs), the more likely it will be that management approves the initial investment. This approach is useful for justifying the extra cost of HEV or BEV vehicles relative to the baseline cost of ICE vehicles.

An approximation for the payback time *n* in years (assuming annual operating costs are fixed) is:

$$n = \frac{Incremental\ Capital\ Cost}{Annual\ Operating\ Cost\ Savings}$$

If annual cash flows for operating cost savings are variable, then the payback period is the amount of time it takes for cumulative annual cash flows from operating cost savings to offset or reduce the initial cash outlay to zero.

$$Incremental\ Capital\ Cost - \sum_{1}^{n} Operating\ Cost\ Savings_{\ i} = 0$$

An improved approach uses Net Present Value (NPV) to account for the time value of money:

$$Incremental\ Capital\ Cost - \sum_{1}^{n} NPV(Operating\ Cost\ Savings_{\ i}) = 0$$

The above formula still fails to account for opportunity cost, but it is a useful rule-of-thumb.

A Frost & Sullivan study of the US Light Duty Truck market also asked the question "Within how many years would you expect to recover the purchase/lease premium of an EV from savings in operating costs?" (Kar & Randall, 2010) Based on feedback from interviews with 80 fleet managers, the mean value for the maximum acceptable time to payback the initial incremental costs was 4.3 years. If the forecasted payback time to recover the upfront incremental vehicle price was less than this maximum acceptable threshold of 4.3 yrs., a fleet manager would most likely favour purchasing the vehicle under consideration. Conversely, if the forecasted payback time were greater than this 4.3-year threshold, a typical fleet manager would be reluctant to purchase the vehicle.

Appendix B. Background to Alternative Energy Vehicle Types

Powertrain configurations can be classified in different ways such as Power Source (e.g. internal combustion engine, electric, fuel cell, etc.), Powertrain Topology (e.g. parallel, series, power-split), or Degree of Hybridization (e.g. mild hybrid, full-hybrid, etc.). In general, they fall into one of the following categories:

- **Internal Combustion Engine (ICE) Vehicle**
- **Series Hybrid Electric Vehicle (HEV)**
- **Parallel Hybrid Electric Vehicle (HEV)**
- **Hybrid Hydraulic Vehicle (HHV)**
- **Plug-In Hybrid Electric Vehicle (PHEV)**
- **Battery Electric Vehicle (BEV)**

These are described in detail below.

Internal Combustion Engine (ICE) Vehicle

A conventional gasoline or diesel internal combustion engine (ICE) vehicle uses the engine as the source of motive power, and transfers torque to the wheels through a mechanical drive-train coupling (for a truck this typically consists of a transmission, driveshaft, and a differential or transaxle) as shown in Figure 52 (Ehsani & Gao, 2005).

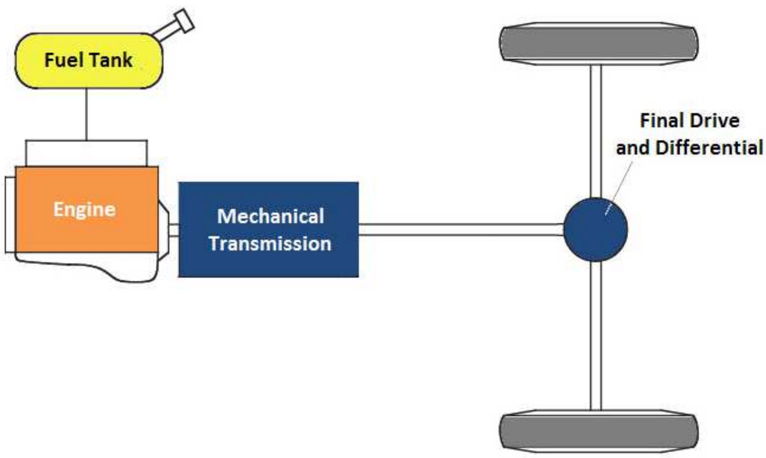


Figure 52 - Internal Combustion Engine Powertrain [Source: Adapted from(Ehsani & Gao, 2005)]

The main advantage of a conventional ICE vehicle is that gasoline and diesel fuels possess a very high energy density which allows the engine to supply the vehicle with a good performance and long operating range. However, there are many noteworthy disadvantages of a typical ICE vehicle: they suffer from poor fuel economy, their exhaust emissions (C02, NOx) have a major environmental impact, and they are dependent on the finite and expensive world oil and fossil fuel reserves that are becoming more depleted. Low fuel economy results from a mismatch of vehicle operational requirements with the optimum fuel efficiency characteristics of the engine. In an urban driving cycle with frequent stops and starts, the vehicle loses a considerable amount of energy during repeated braking and acceleration (Ehsani & Gao, 2005).

Series Hybrid Electric Vehicles (HEV)

In a typical series hybrid vehicle powertrain, all torque delivered to the wheels of the vehicle is provided by an electric motor. The electric power for the motor originates either from a battery pack or from a generator powered by a gasoline or diesel ICE engine (Ehsani & Gao, 2005). See Figure 53.

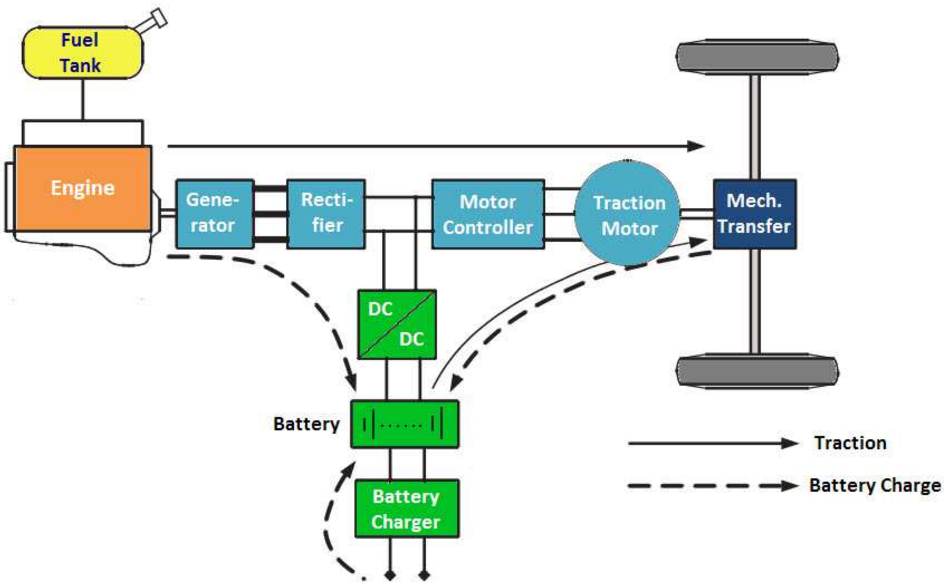


Figure 53- Series Hybrid Electric Vehicle Powertrain [Source: Adapted from(Ehsani & Gao, 2005)]

An energy management algorithm in the powertrain electronic control unit will optimize the proportion of electric power delivered by the battery versus to the generator source. The battery pack can be recharged by either regenerative braking or by using the engine and generator set. In a series powertrain, the engine is much smaller since it sized to deliver power to meet only average power demands rather than peak demands. On the other hand, the battery capacity of a series HEV is larger than the battery in a parallel HEV to be able to satisfy peak power demands. Series HEVs are more expensive than parallel HEVs because of more costly batteries (larger capacity), and the extra cost of adding a generator to the configuration (Ehsani & Gao, 2005).

Parallel Hybrid Electric Vehicle (HEV)

In a parallel HEV, the torque demands of the vehicle are shared by both the engine and the electric motor working in tandem. A power-split transmission allows both power sources to deliver torque to the wheels (Ehsani & Gao, 2005). See Figure 54.

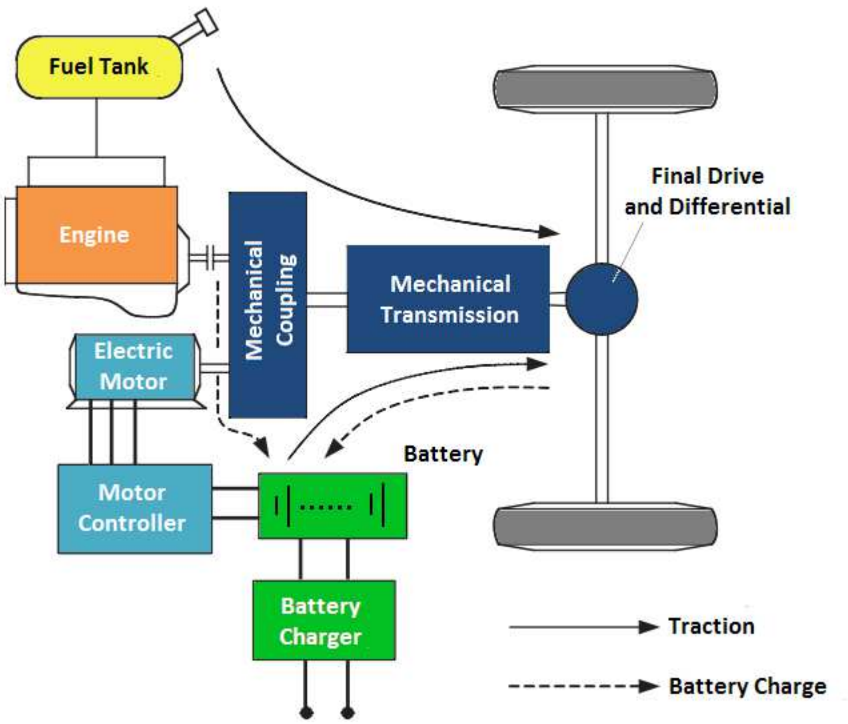


Figure 54 - Parallel Hybrid Electric Vehicle Powertrain [Source: Adapted from(Ehsani & Gao, 2005)]

A parallel HEV supports a mechanism called Regenerative Braking to recover energy in a battery by using the AC induction motor as an electric generator. During braking, the kinetic energy of the HEV is converted back into electricity to recharge the battery pack. This method is analogous to the way that alternators are used in a conventional vehicle.

In a parallel HEV configuration, the ICE engine is connected directly to the wheels, which in turn eliminates energy transfer losses during conversion from mechanical energy to electrical energy and back. Consequently, parallel HEVs are more efficient for highway driving cycles. On the other hand, for stop-and-go city driving cycles with highly irregular power demands, the engine does not operate as efficiently as on the highway (Ehsani & Gao, 2005).

Hybrid Hydraulic Vehicles (HHV)

HHVs are similar to electric hybrids as they both use an ICE as the primary power source. Instead of electric power, an HHV powertrain uses compressed hydraulic fluid as the secondary power source to the primary power source of the ICE engine. In a hydraulic hybrid powertrain, there are four key components as follows: a fluid reservoir, a hydraulic pump actuator or impeller, the hydraulic fluid itself, and an accumulator that contains pressurized hydraulic fluid (Ehsani & Gao, 2005) (Figure 55).

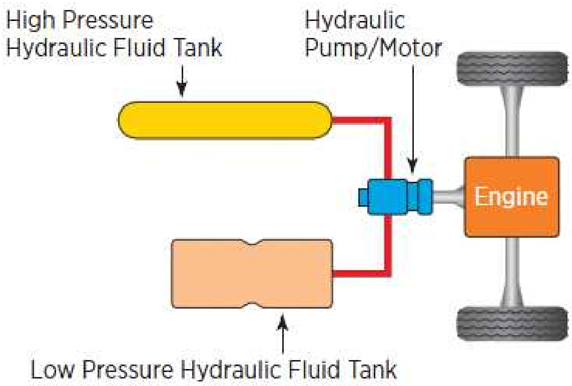


Figure 55 - Parallel Hydraulic Hybrid Vehicle Powertrain [Source: (US Department of Energy, 2010)]

An HHV vehicle also supports regenerative braking. Kinetic energy in a HHV is used during braking to transfer energy to a pump that transfers the fluid from the reservoir, and pressurizes it in the accumulator. The process works in reverse when the vehicle accelerates. The highly compressed hydraulic fluid expands, and drives an impeller to power the vehicle.

HHV vehicles have some advantages over electrical HEV vehicles. First, HHVs do not require expensive batteries. Secondly, the hydraulic accumulator components used by HHVs are more environmentally friendly than the battery packs used by electric hybrid systems (since the manufacturing and disposing of batteries involves dealing with highly toxic waste). HHV disadvantages include challenges with excessive noise of the hydraulic pumps, and difficulties in finding enough available room on a truck to integrate hydraulic components (Ehsani & Gao, 2005).

Plug-in Hybrid Electric Vehicles (PHEV)

A typical PHEV (also known as a range-extended electric vehicle) configuration is very similar to a traditional hybrid-electric vehicle, but adds the ability to plug the vehicle into a charging pedestal to restore the batteries to a fully charged state. A PHEV shares the characteristics of both a conventional HEV and an all-electric BEV vehicle. Like an HEV, it has both electric motor and conventional ICE power sources. In addition, like a BEV, it has a plug for connecting to the electrical grid.

A PHEV vehicle runs entirely on battery power without being recharged (referred to as “Charge Depletion” mode) for anywhere from 10 to 40 miles - called the All Electric Range (AER). Once the AER is reached, the PHEV battery switches to a “Charge Sustaining” mode where the PHEV will behave much like a conventional hybrid (HEV). A suffix is used to indicate the size of the All Electric Range. Therefore, PHEV-10 would have an AER of 10 miles, and PHEV-40 would have an AER of 40 miles. Figure 56 illustrates these two operating modes (Ehsani & Gao, 2005).

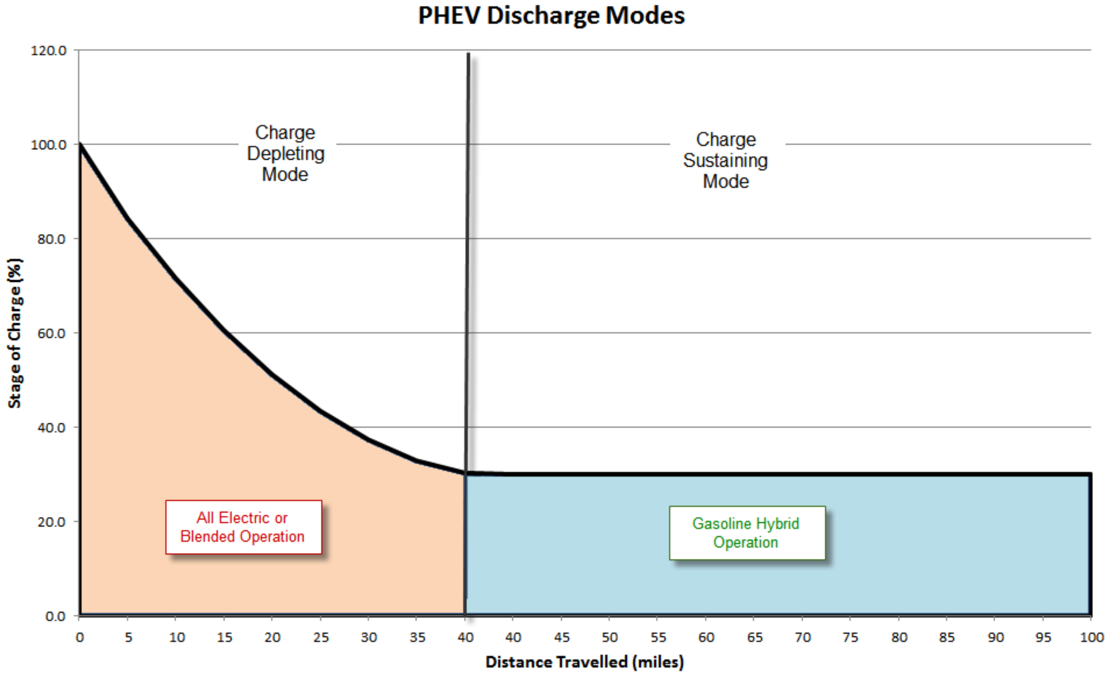


Figure 56 - PHEV Battery Discharge Modes
Source of Data: (Electrification Coalition, 2010)

Battery Electric Vehicles (BEV)

Also referred to as an "all-electric vehicle", "full electric vehicle", or "zero emission vehicle", a BEV converts energy from a battery to power one or more electric motors to provide vehicle propulsion and to operate auxiliary loads (accessories). Like a PHEV, the batteries in a BEV vehicle are frequently charged by plugging the vehicle into the electrical grid at any 120 V or 240V charging pedestal. A BEV vehicle does not have an ICE engine, and thus lacks the ability to use the engine as a secondary power source once the battery is depleted (Ehsani & Gao, 2005) (Figure 57).

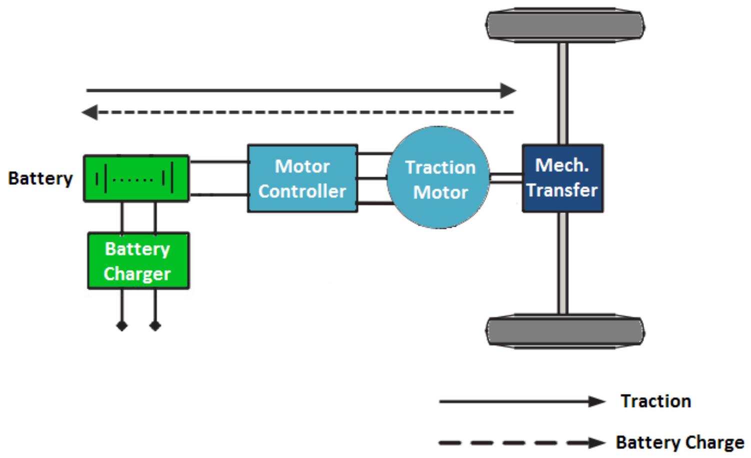


Figure 57 - Battery Electric Vehicle Powertrain [Source: Adapted from (Ehsani & Gao, 2005)]

Maintenance is minimal since BEVs have few moving parts. Since there is no ICE engine, there are no oil changes, tune-ups, and the vehicle produces no exhaust. BEVs are more energy efficient than gasoline engines and are very quiet in operation.

BEVs unfortunately have three important disadvantages: cost, limited range, and recharging time. First, BEVs require a much larger capacity battery (often more than 4x larger) than a conventional hybrid, since the battery is the only energy source for the electric motor used for propulsion. Thus, battery costs are correspondingly higher. Secondly, limited range also is a disadvantage. Under moderate temperatures, a BEV might travel only 60-70 miles or so on a single charge. Moreover, the range of a BEV could be reduced by as much as 50% in cold weather. Finally, the recharging time issue potentially limits the number of shifts or the daily vehicle utilization. Taxi services typically run two shifts a day, and prefer hybrid HEV technology to all-electric BEV vehicles, since they cannot afford the charging time. Postal services are less sensitive to charging time since many postal vehicles run only one shift per day.

Summary Comparison of Powertrain Attributes

The degree of hybridization distinguishes between the options above (Figure 58).

Powertrain Classification by Degree of Hybridization

	Conventional Vehicle	Mild Hybrid Electric Vehicle	Full Hybrid Electric Vehicle	Plug-in Hybrid Electric Vehicle	Battery Electric Vehicle	Hydraulic Hybrid Electric Vehicle
Uses an internal combustion engine as a one source of motive power.	★	★	★	★		★
Shuts of the engine at stop-lights and stop-and-go traffic		★	★	★		★
Uses a hydraulic or pressurized fluid power source to assist a conventional engine						★
Uses an electric motor to assist a conventional engine		★	★	★		
Uses regenerative braking		★	★	★	★	★
Can drive at times using only the electric motor			★	★	★	
Recharges batteries while plugged into a standalone charging station and has an all-electric range of >20+ miles				★	★	

Figure 58 - Powertrain Classification by Degree of Hybridization (Source: Adapted from HybridCenter.org)

Finally, Table 32 provides a summary of the key characteristics, advantages and disadvantages of these powertrain options.

Characteristic	Powertrain Type Internal Combustion Engine (ICE)	Hybrid Electric Vehicle (HEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)	Hydraulic Hybrid Vehicle (HHV)
Propulsion	• Internal Combustion Engine	• Electric Motor Drive (Series HEV variant) • Internal Combustion Engine and Electric Motor Drive (Parallel HEV variant)	• Electric Motor Drive • Internal Combustion Engine	• Electric Motor Drive	• Hydraulic Pump / Impeller (Series HHV variant) • Internal Combustion Engine and Hydraulic Pump / Impeller (Parallel HHV variant)
Energy System	• Internal Combustion Engine	• Battery • Internal Combustion Engine • Ultracapacitor (optional)	• Battery • Internal Combustion Engine • Ultracapacitor (optional)	• Battery • Ultracapacitor (optional)	• High pressure fluid accumulator, low-pressure fluid reservoir • Internal Combustion Engine
Energy Source & Infrastructure	• Filling Stations (Gasoline or Diesel)	• Filling Stations (Gasoline or Diesel)	• Filling Stations (Gasoline or Diesel) • Electric grid charging facilities	• Electric grid charging facilities	• Filling Stations (Gasoline or Diesel)
Key Characteristic	• Uses a fuel tank to store either gasoline or diesel fuel. Combustion of fuel takes place in the engine cylinders that deliver mechanical energy to the driveshaft and transaxle to propel the vehicle.	• Combines ICE with electric motor for propulsion. • ICE provides the main power at constant speeds • Electric motor provides power assist for start-up and acceleration • HEV battery is in Charge-Sustaining mode (periodically recharged by ICE or by regenerative braking)	• Combine ICE with electric motor for propulsion (like HEVs). • PHEVs can be charged and recharged by plugging into the electric grid. • PHEVs can run in an all-electric (charge-depletion) mode or in hybrid mode.	• Electric motor converts energy from a battery or ultracapacitor for motive power. • EVs are charged by plugging into electrical grid.	• Combines ICE and hydraulic pump for propulsion. • ICE provides the main power at constant speeds • Hydraulic pump provides power assist for start-up • Regenerative braking energy can be used to increase reservoir pressure.
Advantages	• High energy density of petroleum fuel • Relatively low cost • Long Range	• Uses existing infrastructure • Smaller ICE engine • Small Battery Size • Reduced fuel consumption • Quiet operation • Reduced CO2 emissions • Reduced NOx emissions • Long Brake Life • Accessory Power	Same advantages as HEV (except battery size) PLUS.... • Extended range • Uses all-electric (charge-depletion) mode for initial range – low emissions. • External Plug-In Charging Eliminates reliance on single fuel source.	• Energy Conversion Efficiency • Environmental - Zero emissions • Low cost to recharge • Mechanical Simplicity • Lower Maintenance Costs • Quiet • No ICE components needed	• Uses existing infrastructure • Smaller ICE engine • Reduced fuel consumption • Reduced CO2 emissions
Disadvantages and Issues	• Inefficient at low rpm • Large ICEs used to satisfy peak power demand • Air Pollution • Fossil Fuel Usage • Foreign Oil Dependency	• Very limited electric-only range • Uses both ICE and electric powertrain components • Fuel savings is dependent on driving cycle	• High Initial Cost • Large battery size (bigger than HEV) • Uses both ICE and electric powertrain components	• High Initial Cost Limited Range • Larger Battery Size (> HEV and PHEV) • Battery Life • Cabin Heating • Access to electric grid for charging	• High initial cost • Lower energy density than battery technology • Accumulator can occupy large amount of space.

Table 32- Types of Vehicle Powertrains [Source: adapted from (Chan, 2002)]

Appendix C. TCO and Payback Model – Scenario Assumptions

The cost assumptions for the TCO and Payback model vary for each market segment and powertrain technology, both for initial capital costs as well as for operating costs. Each of the three forecasting scenarios (optimistic, pessimistic, and most likely) uses different assumptions over 2010-2030 for battery cost reductions, fuel price increases, electricity price increases, and maintenance cost increases.

Incremental Costs of Vehicle Acquisition

The capital cost of a truck can vary considerably by powertrain technology. Hybrid-electric vehicles (HEVs), plug-in hybrids (PHEVs) and battery electric vehicles (BEVs) require additional components not found in an ICE vehicle including lithium-ion batteries, traction motors, power inverters, onboard chargers, and other powertrain electronics (see Table 33).

Table 33 - Component Requirements by Powertrain Technology

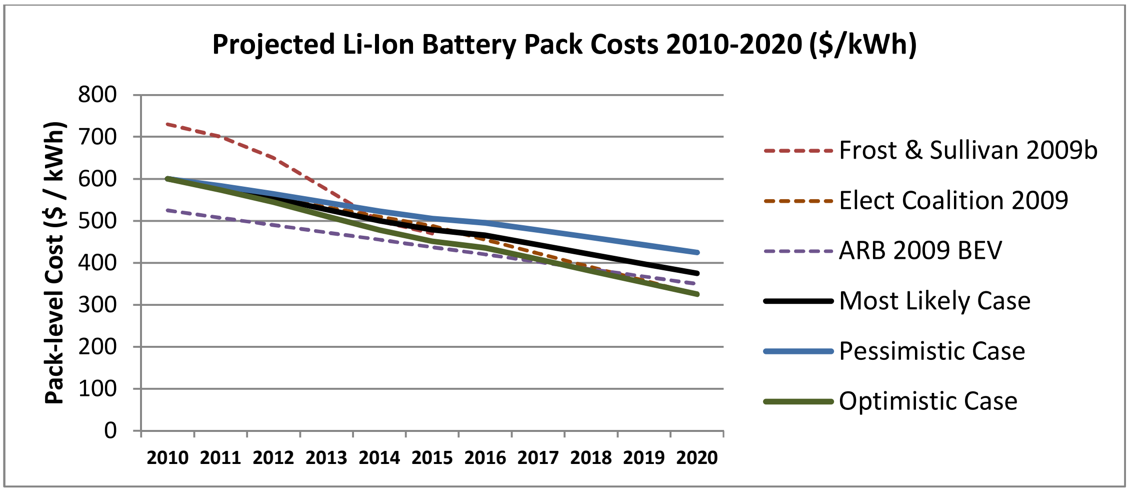
Component Type	ICE	HEV	PHEV	BEV
Baseline Vehicle Chassis	✓	✓	✓	✓
Internal Combustion Engine	✓	✓	✓	
Exhaust System and Fuel Tank	✓	✓	✓	
Battery *		✓	✓✓	✓✓✓
Electric Traction Motor		✓	✓	✓
Power Inverter		✓	✓	✓
Accessory Power		✓	✓	✓
Onboard Charger		✓	✓	✓
Electronics		✓	✓	✓
Integrated Starter Generator		✓	✓	
EVSE (charging pedestal)			✓	✓
Single Speed Transmission				✓

* Multiple tic-marks indicate a larger battery size is required – at greater cost.

The size and cost of these components vary by the drivetrain configuration (HEV, PHEV, or BEV) and by the duty class of vehicle (LCV, MCV, and HCV). The motive power from an electric motor enables smaller engines to be used for HEVs and PHEVs, or entirely eliminated for BEVs. An HEV may use an integrated starter generator to permit the engine to be started often to recharge the battery. Battery capacity and costs are larger for a PHEV than an HEV, and even larger still for a BEV. A full BEV adds the cost of a single-speed transmission. Plug-in vehicles (both PHEVs and BEVs) require charging infrastructure to support the vehicle.

Battery Cost Scenarios

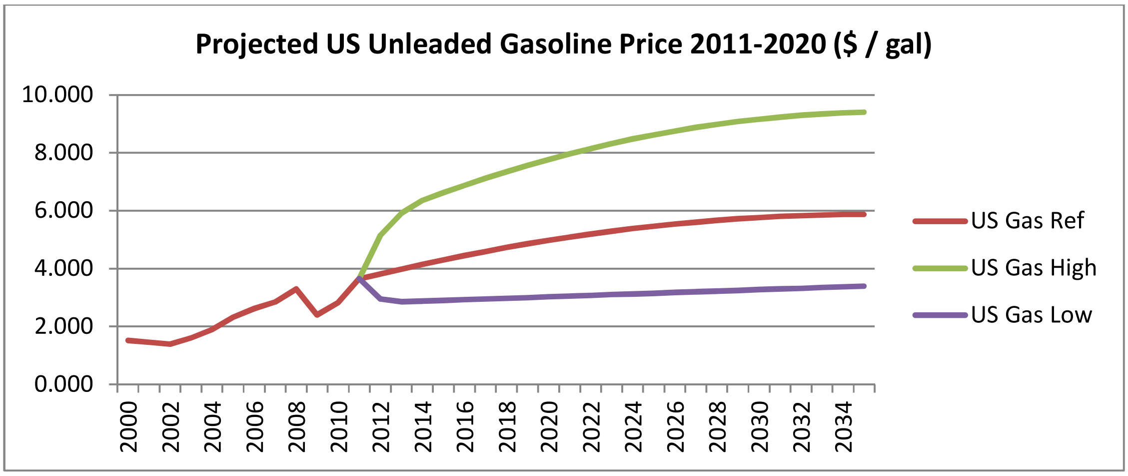
Due to the uncertainty about the extent to which battery costs will decrease over time, the price of the battery is listed separately from the capital costs for the other components. This model has separate battery cost profiles for the three forecasting scenarios (optimistic, pessimistic, and most likely). Current average lithium-ion battery production cost is roughly $600 per kilowatt hour (kWh) with costs decreasing to approximately $375 per kWh by 2020. Incremental costs for HEV and BEV vehicles are highly dependent on component sizing. The cost of a lithium-ion battery pack may run from about $4000 for a small 3kWh pack for a HEV. For a PHEV with a 16 kWh battery, the incremental battery cost is $9,600. Costs rise to $20,000 or more for a large 28kWh battery pack for a full BEV.



Vehicle Attribute	Vehicle Duty Class North America and Europe		
	LCV	MCV	HCV
Battery Capacity - HEV (kWh)	1.8	3	8
Battery Capacity - PHEV (kWh)	14	28	-
Battery Capacity - BEV (kWh)	28	65	-

Fuel Cost Scenarios

For this analysis, three scenarios (reference or most likely, high, and low) were created to project fuel price profiles over time. The cumulative annual growth rate (CAGR) profile used to extrapolate average gasoline prices is the same as the growth factor used to forecast the long-term price of crude oil as presented in the US Department of Energy's 2009 Annual Energy Outlook (US Department of Energy, 2009).



Electricity Cost Scenarios

For commercial customers, electricity prices are assumed to vary during peak and off-peak hours of the day. Peak charging rates are assumed to be significantly higher than off-peak, reaching nearly 20 cents per kWh in 2030. Annual energy costs are slightly lower for EVs than for PHEVs, but are steady at roughly $325 throughout the forecast period. As electricity prices increase, motor efficiency also increases, partially offsetting the high cost of energy. For PHEVs, annual electricity costs are slightly lower than for EVs, because these vehicles will still rely on gasoline for an estimated 25 percent of VMT. Therefore, total PHEV energy savings are less than those for pure EVs.

According to the Fleet Electrification Roadmap report prepared by the Electrification Coalition, electricity prices have been much more stable than oil prices over the last 25 years (Electrification Coalition, 2010). Historically, average retail electricity prices have risen by less than 2 percent per year since 1983. A major reason for this is the fact that retail electricity prices are less affected by the price of crude oil than retail gasoline prices. The cost of the fuel feedstock for electrical generation gas is a relatively small component of the overall cost of electricity. Electricity prices are expected to continue to rise steadily but slowly.

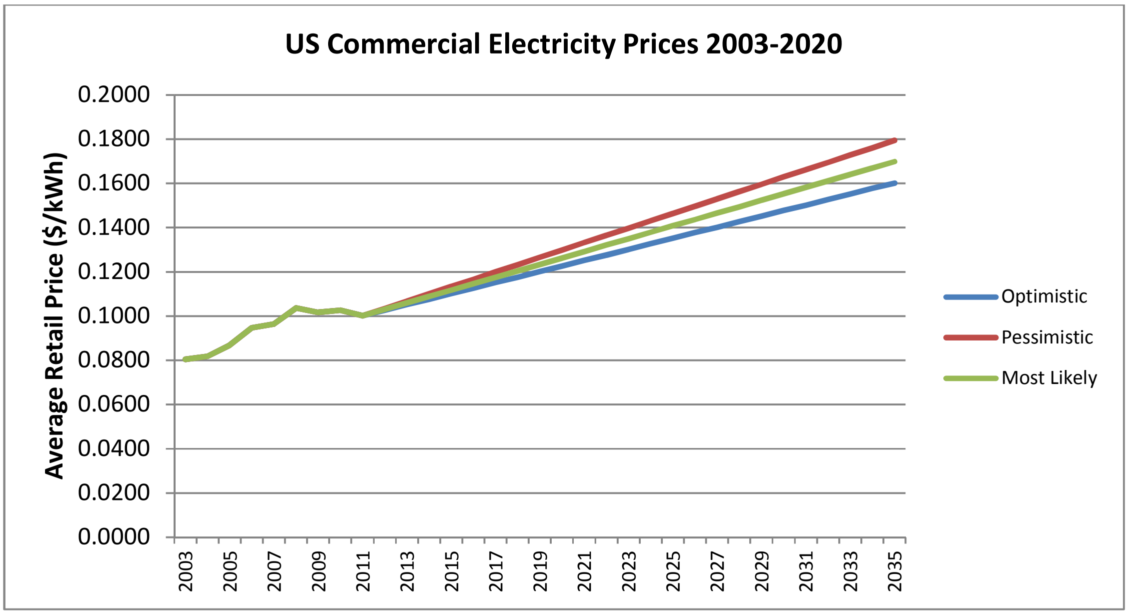


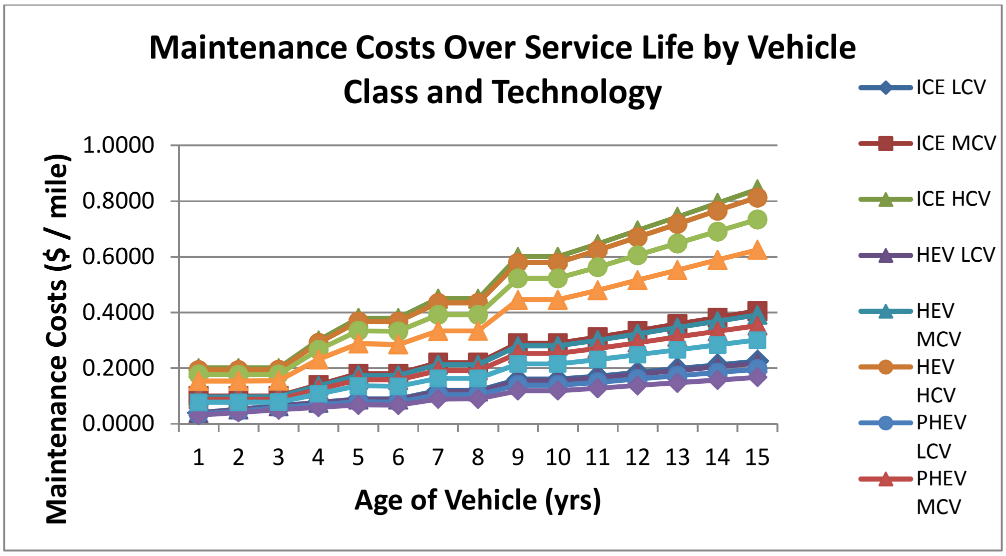
Figure 59 - US Commercial Electricity Prices 2003-2020 – Source: US Department of Energy, Current and Historical Monthly Retail Sales, Revenues and Average Revenue (Form EIA-826)

Maintenance Cost Scenarios

Maintenance and service costs represent a significant portion of the operating budget of most fleet managers today. ICE vehicles require a number of regularly scheduled services as well as maintenance and replacement costs at key mileage milestones. Regularly scheduled service events could include oil changes and other fluid service, such as transmission and brake fluid. As vehicle age increases in terms of miles, repair and replacement costs rise for items such as transmissions, brake pads, engine components, and ultimately the engine itself.

While all of this is no doubt true for vehicles owned by typical consumers, fleet operators are likely to be more acutely aware of the costs over time. As internal combustion engine vehicles reach certain mileage tipping points, maintenance service can rise to as much as 20 to 30 percent of annual operating costs in certain vehicle applications. For fleet managers, this is a significant expense. In fact, fleet operators tend to sell vehicles in advance of certain mileage milestones or in advance of warranty expiration in order to avoid incurring the maintenance costs—though the cost may ultimately be paid in reduced residual value.

The maintenance and repair costs of electric drive vehicles are likely to be significantly less than those associated with traditional internal combustion engine vehicles. This is a result of the fact that electric drive systems tend to have fewer moving parts and wear items than internal combustion engines. The maintenance savings are most significant for EVs which are based on the simplest design. PHEVs that tend to operate in charge-depleting mode can also sharply reduce maintenance costs. The benefit is least significant for HEVs.



Vehicle Economy (Fuel and Electricity Consumption)

Over the life of the vehicle, both PHEVs and EVs will provide consumers with substantial cost savings, particularly in terms of fuel. For a light-duty LCV electric vehicle the operating cost is typically about 2.5 to 3 cents a mile, whereas the operating cost for a light-duty LCV vehicle using a conventional ICE engine with 20mpg fuel economy is about 15 cents per mile. These estimates are based on fuel economy figures shown in Table 34 and Table 35. Annual energy savings from reduced gasoline consumption are highest for EVs, which use no gasoline. By 2030, annual gasoline savings for EV drivers reaches nearly $2,000. It is assumed that 75 percent of the miles traveled by PHEVs will be electric miles. Electricity consumption offsets the savings from reduced gasoline consumption.

Fuel Economy Category	Vehicle Duty Class - North America		
	LCV	MCV	HCV
ICE Fuel Economy - Diesel (mpg)	21	5	3.5
ICE Fuel Economy - Gasoline (mpg)	19	4.8	-
Hybrid Fuel Economy - Diesel (mpg)	32	8	4.8
Hybrid Fuel Economy - Gasoline (mpg)	30	7	-
Electric Mode Economy (kWh/mile)	0.346	1.038	-

Table 34- Fuel Economy Assumptions by Duty Class - North America

Fuel Economy Category	Vehicle Duty Class - Europe		
	LCV	MCV	HCV
ICE Fuel Economy - Diesel (L/100km)	11.19	47	67
ICE Fuel Economy - Gasoline (L/100km)	12.37	49	-
Hybrid Fuel Economy - Diesel (L/100km)	7.35	29	49
Hybrid Fuel Economy - Gasoline (L/100km)	7.8	33.5	-
Electric Mode Economy (kWh/km)	0.215	0.645	-

Table 35 - Fuel Economy Assumptions by Duty Class - Europe

Vehicle Utilization and Daily Range

Vehicle Attribute	Vehicle Duty Class - North America		
	LCV	MCV	HCV
All Electric Range - PHEV (miles)	20	20	-
All Electric Range - BEV (miles)	70	70	-
Daily VMT Utilization - Government (miles)	40	-	-
Daily VMT Utilization - Service (miles)	70	70	100

Table 36 - Vehicle Utilization and Range Assumptions - North America

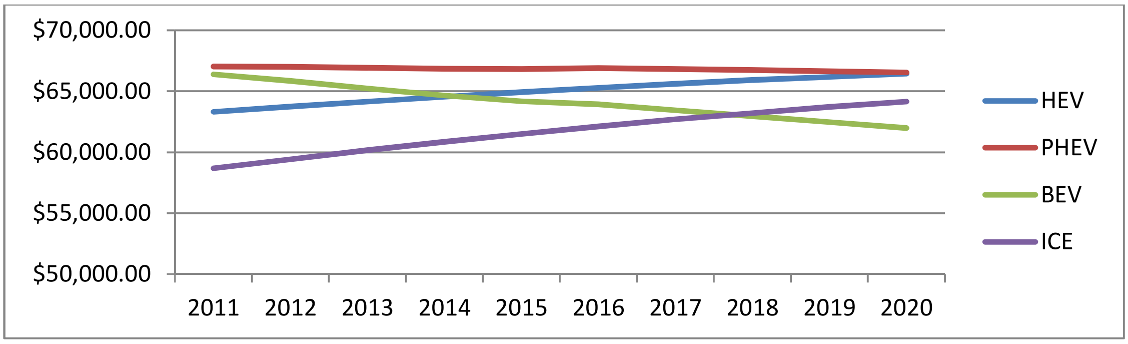
Vehicle Attribute	Vehicle Duty Class - Europe		
	LCV	MCV	HCV
All Electric Range - PHEV (km)	32.2	32.2	-
All Electric Range - BEV (km)	112.7	112.7	-
Daily VKT Utilization - Government (km)	64.4	-	-
Daily VKT Utilization - Service (km)	112.7	112.7	160.9

Table 37 - Vehicle Utilization and Range Assumptions - Europe

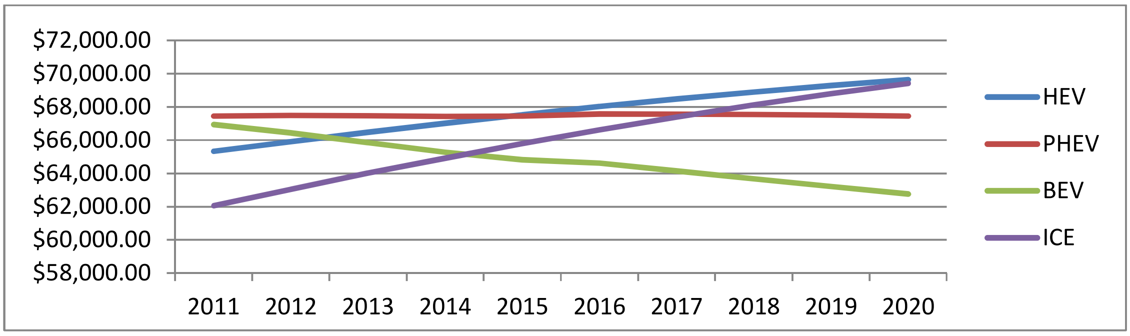
A vehicle's utilization rate is essentially the number of miles traveled over a given period of time, though there are important exceptions. For example, utility and telecom service vehicles may run the engine and consume fuel in order to perform certain auxiliary functions. These functions may make such vehicles strong candidates for electrification. Still, the most straightforward measure of vehicle utilization is annual miles traveled. In general, commercial and corporate fleet vehicles tend to have higher annual miles traveled than passenger vehicles in the consumer market.

Appendix D. Total Cost of Ownership (TCO) By Market Segment

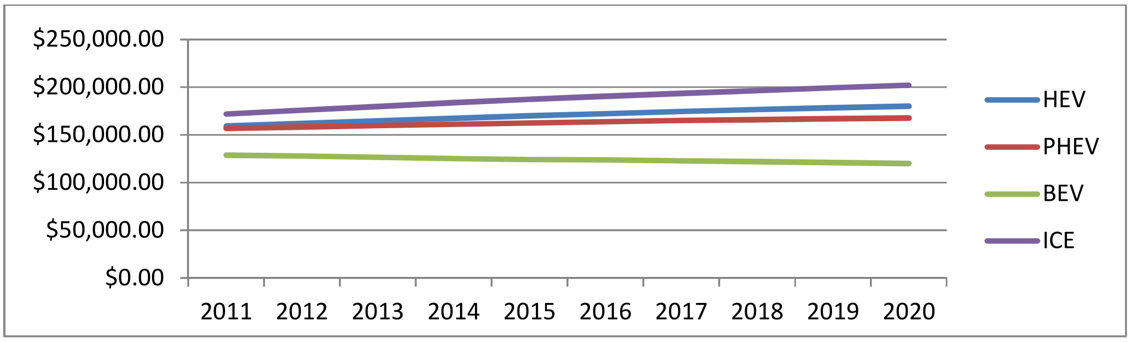
TCO for North American LCV Government Segment – Most Likely Scenario



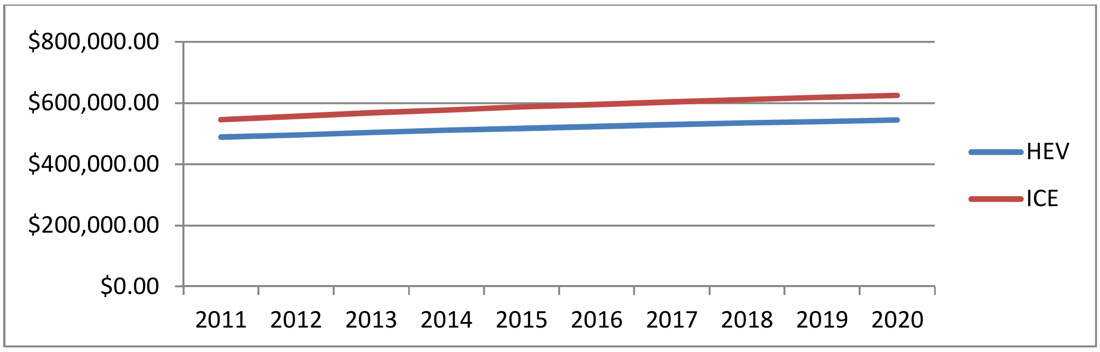
TCO for North American LCV Service Segment – Most Likely Scenario



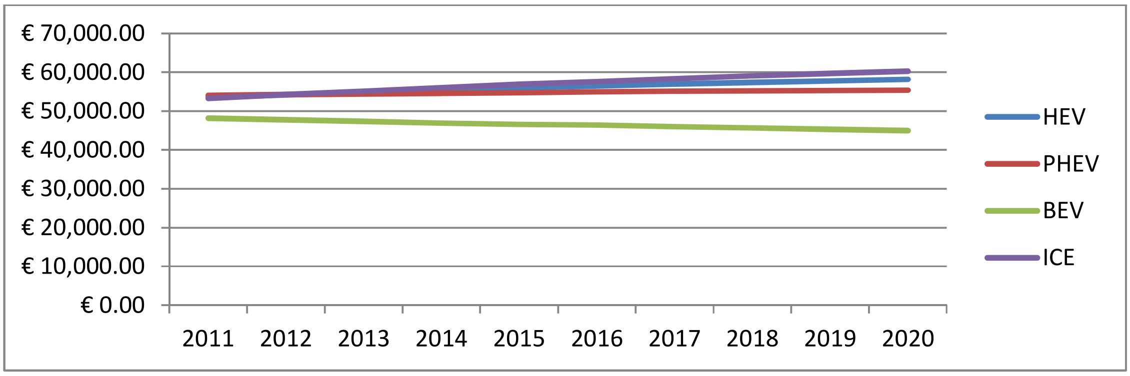
TCO for North American MCV Service Segment – Most Likely Scenario



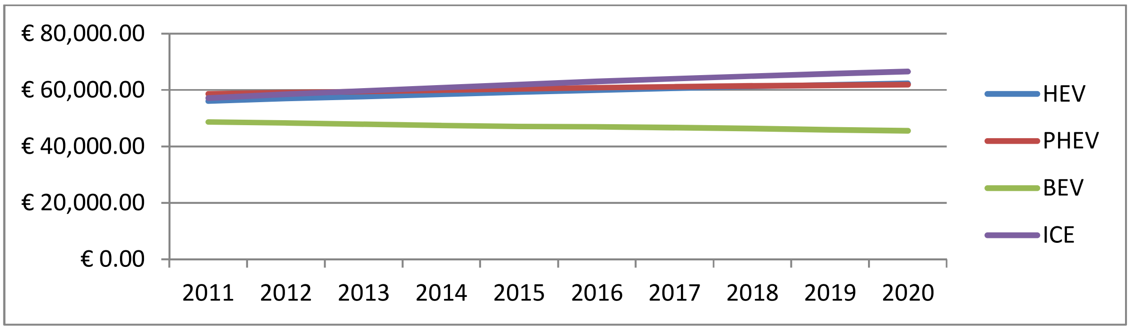
TCO for North American HCV Service Segment – Most Likely Scenario



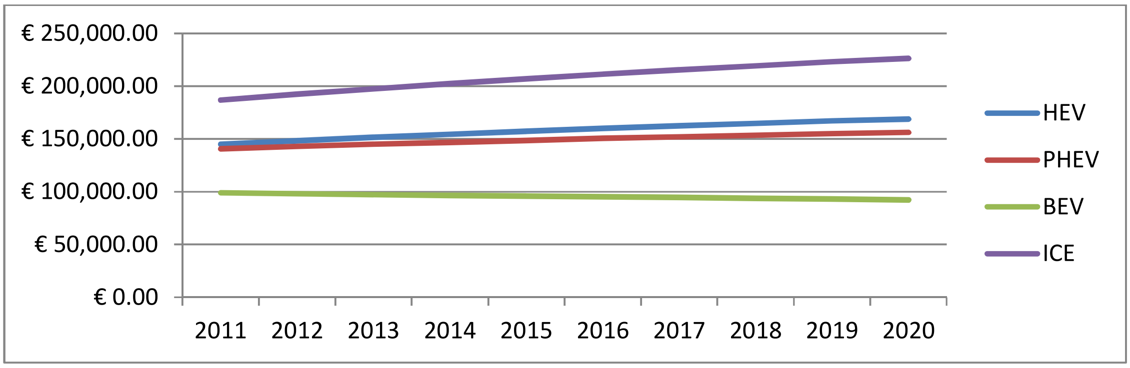
TCO for European LCV Government Segment – Most Likely Scenario



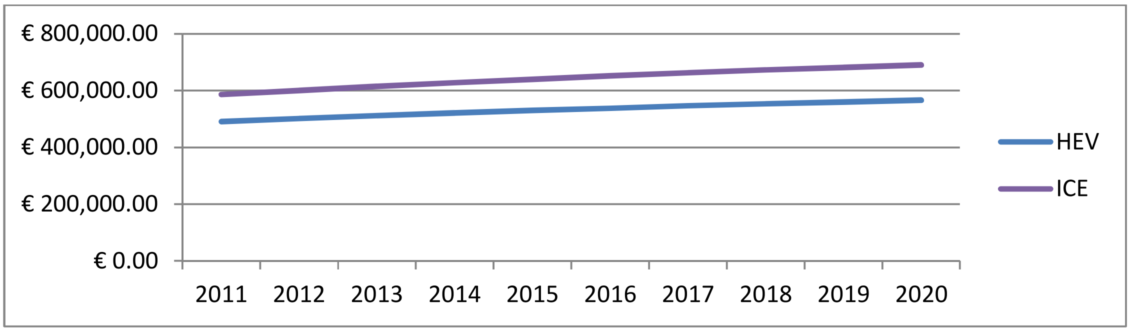
TCO for European LCV Service Segment – Most Likely Scenario



TCO for European MCV Service Segment – Most Likely Scenario

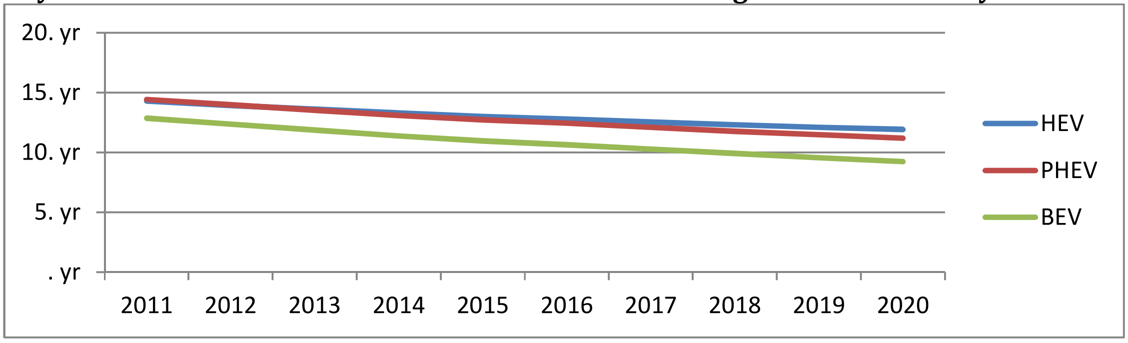


TCO for European HCV Service Segment – Most Likely Scenario

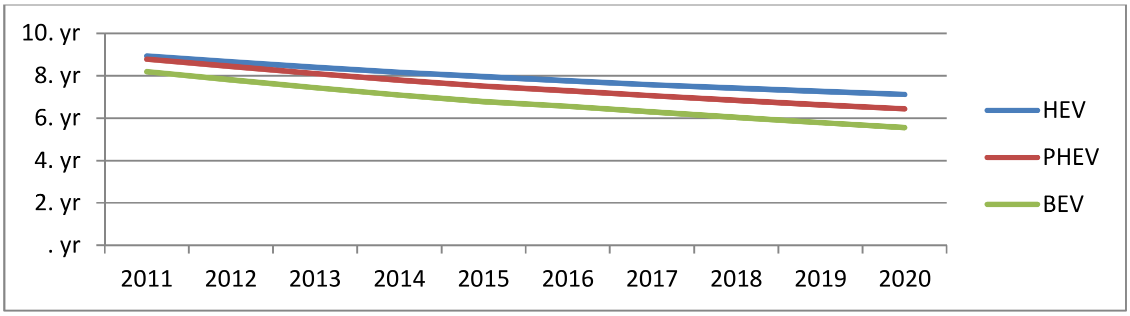


Appendix E. Payback Analysis – Results by Market Segment

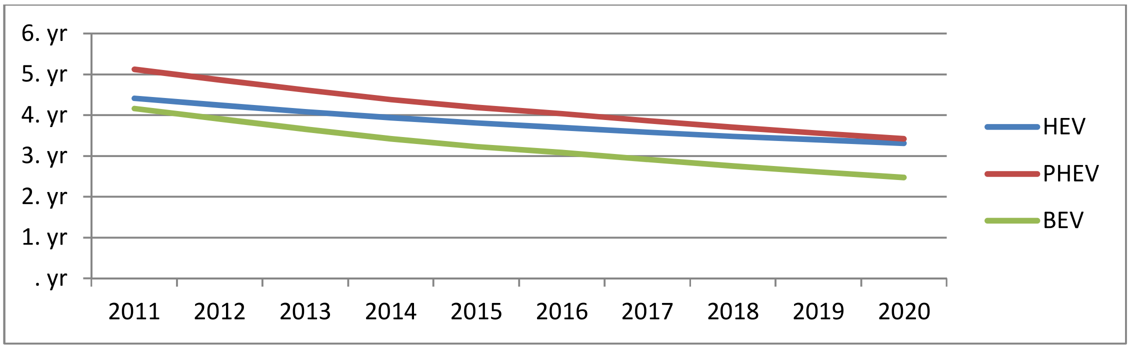
Payback Period for North American LCV Government Segment – Most Likely Scenario



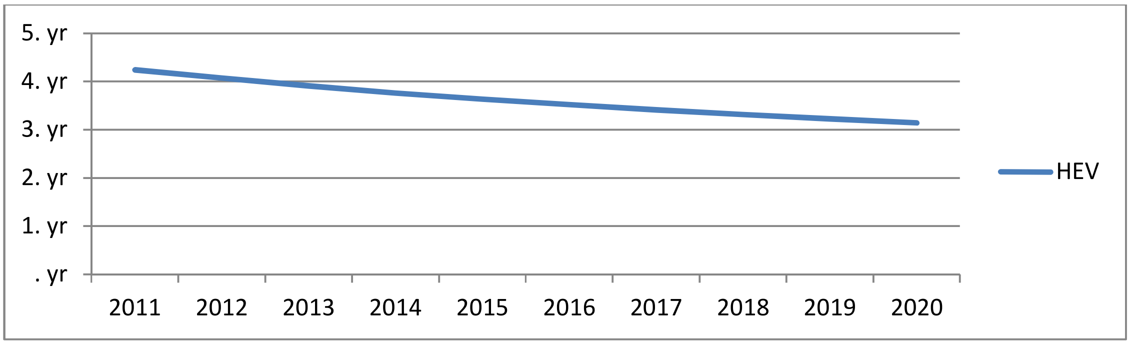
Payback Period for North American LCV Service Segment – Most Likely Scenario



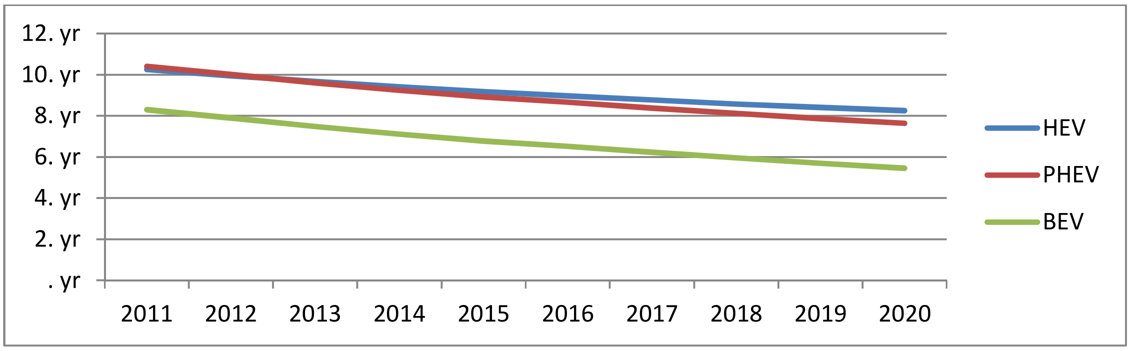
Payback Period for North American MCV Service Segment – Most Likely Scenario



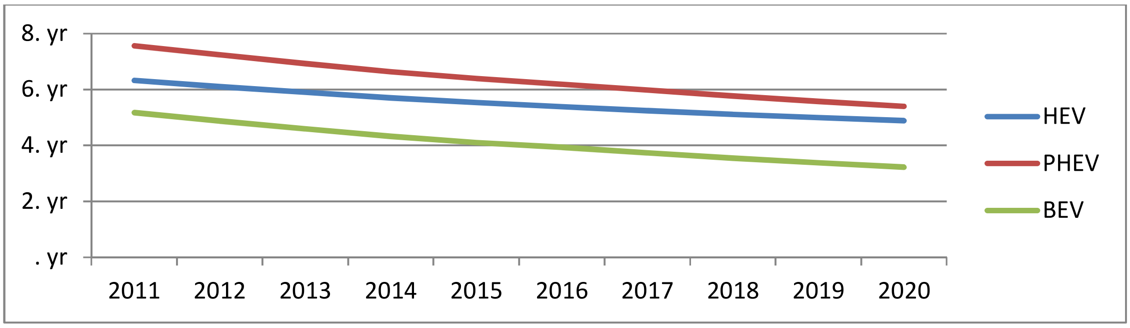
Payback Period for North American HCV Service Segment – Most Likely Scenario



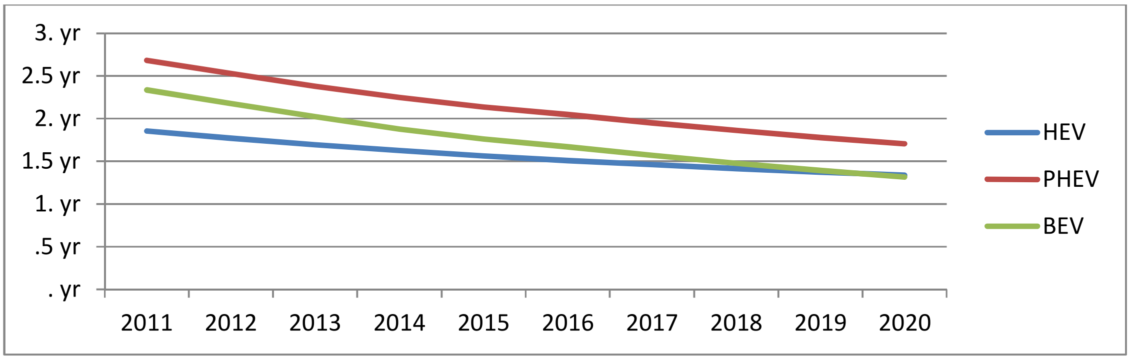
Payback Period for European LCV Government Segment – Most Likely Scenario



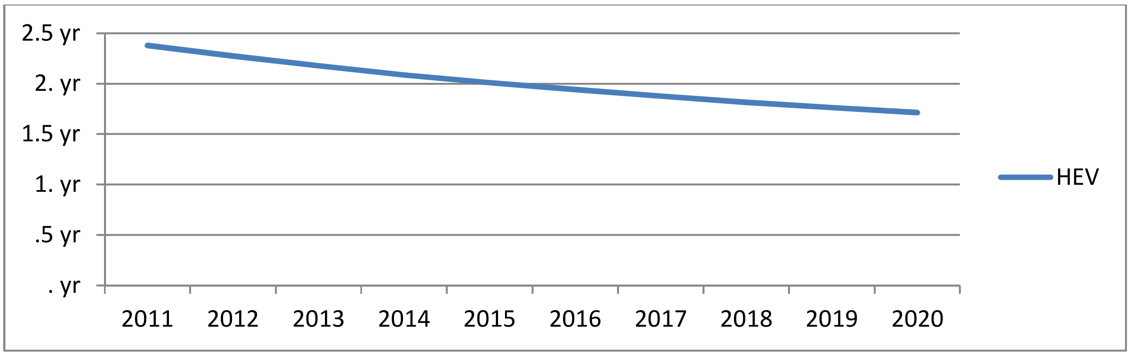
Payback Period for European LCV Service Segment – Most Likely Scenario



Payback Period for European MCV Service Segment – Most Likely Scenario



Payback Period for European HCV Service Segment – Most Likely Scenario



Bibliography - Works Cited

Automotive Fleet Magazine. (2009). *Top 300 Commercial Fleets 2009*. *Automotive Fleet Magazine*. Automotive Fleet Magazine. Retrieved from http://www.fleet-central.com/TopFleets/pdf/top300_09.pdf

Azure Dynamics. (2011). Azure Dynamics To Begin Integrating Plug-In Hybrid Technology in. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/documents/PR_July27_2011.pdf

Balducci, P. (2008). *Plug-in Hybrid Electric Vehicle Market Penetration Scenarios*. Retrieved from http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17441.pdf

Barney, J. B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99–120. doi:10.1177/014920639101700108

Barney, J. B. (1995). Looking inside for competitive advantage. *Academy of Management Executive*, 9(4), 49–61.

Boardman, A. E., Shapiro, D. M., & Vining, A. R. (2003). A Framework for Comprehensive Strategic Analysis.

Bonoma, T. V, & Shapiro, B. P. (1983). *Segmenting the industrial market*. Lexington Books.

Bukszar, E. (2009). Strategic fit: Aligning organizational resources with strategy. *Western Decision Sciences Annual Conference Proceedings*. Kauai, Hawaii: Western Decision Sciences Institute. Retrieved from http://www.wdsinet.org/papers/

Chan, C. C. (2002). The state of the art of electric and hybrid vehicles. *Proceedings of the IEEE*, 90(2), 247–275. doi:10.1109/5.989873

Cleary, T. P., McGill, R., Sikes, K. G., Hadley, S. W., Marano, V., Ungar, E., & Gross, T. (2010). *Plug-In Hybrid Electric Vehicle Value Proposition Study*. Retrieved from http://www.afdc.energy.gov/afdc/pdfs/phev_study_final_report.pdf

Cleary, T. P., Sikes, K. G., & Lin, Z. (2010). *PHEV Market Introduction Study*. Retrieved from http://www.sentech.org/phev/pdfs/PHEV_Market_Introduction_Study_Report.pdf

Davis, S. C., Diegel, S. W., & Boundy, R. G. (2010). *Transportation Energy Data Book: Edition 29, Report ORNL-6985*. Retrieved from http://cta.ornl.gov/data/tedb29/Edition29_Full_Doc.pdf

Davis, S. C., Diegel, S. W., & Boundy, R. G. (2011). *US Transportation Energy Data Book, Edition 31* (31st ed.). Oak Ridge National Laboratory, Oak Ridge, Tennessee. Retrieved from http://cta.ornl.gov/data/index.shtml

Ehsani, M., & Gao, Y. (2005). Hybrid Drivetrains. In A. Emadi (Ed.), *Handbook of Automotive Power Electronics and Motor Drives*. CRC Press, Taylor and Francis Group LLC.

Electric Power Research Institute. (2007). *Environmental Assessment of Plug-In Hybrid Electric Vehicles Volume 1* (Vol. 1). Electric Power Research Institute. Retrieved from http://my.epri.com/portal/server.pt?Abstract_id=000000000001016496

Electrification Coalition. (2010). *Fleet Electrification Roadmap - Revolutionizing Transportation and Achieving Energy Security*. Retrieved from http://www.electrificationcoalition.org/reports/EC-Fleet-Roadmap-screen.pdf

Fairley, P. (2011). Making Electric Vehicles Pay Off. *Technology Review*, (January/February 2011), 1–2. Retrieved from http://www.technologyreview.com/business/27007/?p1=BI

Fildes, M., Nelson, S., Sener, N., Steiner, F., & Suntharasaj, P. (2007). Marketing Opportunity Analysis for Daimler Chrysler's Sprinter Van Plug-in Hybrid Electric Vehicle. *Management of Engineering and Technology, Portland International Center for* (pp. 1797–1810). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4349506

Goldman Sachs. (2010). *Americas: Clean Energy: Energy Storage - Advanced Batteries: Light, but the tunnel is long*. Retrieved from http://www.voxone.com/eos/articles/GSBatteryReport2010-06-29.pdf

Grant, R. M. (2008). *Contemporary Strategy Analysis* (pp. 143–158).

Hollinshead, M. J., Eastman, C. D., & Etsell, T. H. (2005). Forecasting performance and market penetration of fuel cells in transportation. *Fuel Cells Bulletin*, 2005(12), 10–17. Retrieved from http://www.sciencedirect.com/science/article/pii/S1464285905708671

Indiana University School of Public and Environmental Affairs. (2011). *Plug-in Electric Vehicles: A Practical Plan for Progress*. Retrieved from http://www.indiana.edu/~spea/pubs/TEP_combined.pdf

Intergovernmental Panel on Climate Change. (2007). *Climate Change 2007 Synthesis Report: An Assessment of the Intergovernmental Panel on Climate Change*. Retrieved from http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, 74(1). Retrieved from http://www.mtsu.edu/~jclark/698/articles/698-UsingtheBalancedScorecard.pdf

Kar, S., & Randall, J. M. (2010). *Strategic Analysis of the North American and European Electric Commercial Vehicle Market*. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M4DE-01-00-00-00

Kassatly, S. S. N. (2010). The lithium-ion battery industry for electric vehicles. Retrieved from http://dspace.mit.edu/handle/1721.1/61873

Kotler, P., Adam, S., Brown, L., & Armstrong, G. (2001). *Principles of Marketing*. Pearson Education Australia.

Lowe, M., Ayee, G., & Gereffi, G. (2009). *Hybrid Drivetrains for Medium- and Heavy-Duty Trucks*. Retrieved from http://www.cggc.duke.edu/environment/climatesolutions/greeneconomy_Ch9_HybridDrivetrainsforTrucks.pdf

MIT Energy Initiative Symposium. (2010). Electrification of the Transportation System. *Electrification of the Transportation System, An MIT Energy Initiative Symposium*. Massachusetts Institute of Technology. Retrieved from http://web.mit.edu/mitei/docs/reports/electrification-transportation-system.pdf

Porter, M. E. (1998a). *Competitive Strategy: Techniques for Analyzing Industries and Competitors* (2nd Ed.). The Free Press, A Division of Simon & Schuster Inc. Retrieved from http://books.google.ca/books?id=QN0kyeHXtJMC

Porter, M. E. (1998b). *Competitive Advantage: Creating and sustaining superior performance*. The Free Press, A Division of Simon & Schuster Inc.

Porter, M. E., & Millar, V. (1985). How information gives you competitive advantage. Retrieved from http://www.ida.liu.se/~TDEI65/documents/8500002422.pdf

Rogers, E. M. (2003). *Diffusion of Innovations*. *New York* (5th Editio.). Free Press - a Division of Simon & Schuster Inc.

Schulz, D. A., Berlin, T. U., & Marker, S. (2010). Entering the electric mobility market : an analysis of commercial vehicle fleets Characteristics of commercial fleets. *VDE-Kongress 2010* (pp. 1–6). VDE VERLAG GmbH. Retrieved from http://www.vde-verlag.de/proceedings-en/453304047.html

Supreme Court of British Columbia. (2012). Azure Dynamics CCAA Proceedings - Claims Process Order No. S122223. Vancouver, BC: Ernst & Young Document Centre. Retrieved from http://documentcentre.eycan.com/eycm_library/Azure Dynamics/English/Claims Process/DM_VAN-8428991-v1-Azure_-_Entered_Claims_Process_Order.PDF

U.S. Energy Information Administration. (2010a). *Annual Energy Review 2009*. Retrieved from http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf

U.S. Energy Information Administration. (2010b). *International Energy Outlook 2010*. Retrieved from http://www.eia.doe.gov/oiaf/ieo/

US Department of Energy. (2010). *Clean Cities' Guide to Alternative Fuel and Advanced Medium-and Heavy-Duty Vehicles (Brochure)*. Retrieved from http://www.osti.gov/bridge/servlets/purl/990514-auW62E/990514.pdf

US Department of Energy, E. I. A. (2009). *Annual Energy Outlook 2009 With Projections to 2030* (Vol. 0383).

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, 5(2), 171–180. doi:10.1002/smj.4250050207

Bibliography - Works Consulted

ACT Research. (2009a). *ACT N.A. Commercial Vehicle Outlook*. Retrieved from http://www.actresearch.net/reports/outlook.pdf

ACT Research. (2009b). Report 1 - State of the Industry : Classes 5-8 Vehicles. Americas Commercial Transportation Research Co., LLC. Retrieved from http://www.actresearch.net/reports/soi.pdf

AFS Trinity Power Corporation. (2008). AFS Trinity, Ricardo Announce Joint Extreme Fleet Program to Slash Gasoline and Diesel Use by Car, SUV and Truck Fleets. AFS Trinity Power Corporation. Retrieved from http://afstrinity.com/press/releases/press-release-5-2-08.html

AFS Trinity Power Corporation. (2010). AFS Trinity Power Extreme Hybrid System : the lower cost , higher performance plug-in hybrid alternative. Retrieved from http://afstrinity.com/press/articles/AFST-SystemCost-05Aug2010.pdf

Abell, L., & Oppenheimer, P. (2008). World Lithium Resource Impact on Electric Vehicles. Retrieved from http://action.pluginamerica.org/o/2711/images/World-Lithium-Resource-Impact-on-Electric-Vehicles-v1.pdf

Abuelsamid, S. (2009a). Chrysler unveils new electric minivan for the US Postal Service. AutoBlogGreen. AutoBlog.com. Retrieved from http://green.autoblog.com/2009/04/22/chrysler-unveils-new-electric-minivan-for-the-us-postal-service/

Adcock, I., Boekestyn, A., Chew, E., Leigh, G., & Pedder, S. (2009). The Electric Vehicles and Battery Technology Report - 2009 Edition. Retrieved from http://www.hybrid-ev.com/reports_endpoint.asp?id=27

Adebanjo, D. (2008). Intermediation in downstream automotive supply chains a review of the role of internet technology. International Journal of Automotive Technology and Management, 8(1), 42. doi:10.1504/IJATM.2008.018767

Aggeri, F., Paris, M. D., Elmquist, M., & Pohl, H. (2008). Managing learning in the automotive industry – the race for hybridisation 1, 1(21), 1–21.

Alexander, M. (2008). An Environmental Assessment of Electricity as a Transportation Fuel. National Association of Regulatory Utility Commissioners 2008. Electric Power Research Institute. Retrieved from http://www.narucmeetings.org/Presentations/Marcus Alexander-EPRI-Electricity as a Transportation Fuel.pdf

Amjad, S., Neelakrishnan, S., & Rudramoorthy, R. (2010). Review of design considerations and technological challenges for successful development and deployment of plug-in hybrid electric vehicles. Renewable and Sustainable Energy Reviews, 14(3), 1104–1110. doi:10.1016/j.rser.2009.11.001

An, F., Stodolsky, F., Vyas, A., Cuenca, R., & Eberhardt, J. (1999). Scenario analysis of hybrid class 3-7 heavy vehicles. Retrieved from http://www.osti.gov/bridge/product.biblio.jsp?osti_id=750634

Anastasova, N., & Nenovski, M. (2011). Foreign Investments in the Chinese Automobile Industry: Analysis of Drivers, Distance Determinants and Sustainable Trends. Analysis. Retrieved from http://pure.au.dk/portal-asb-student/files/39889345/Master_Thesis_Nadezhda_Anastasova_and_Martin_Nenovski.pdf

Andersen, P. H., Mathews, J. a., & Rask, M. (2009). Integrating private transport into renewable energy policy: The strategy of creating intelligent recharging grids for electric vehicles. *Energy Policy*, *37*(7), 2481–2486. doi:10.1016/j.enpol.2009.03.032

Anderson, D. (2009). *An Evaluation of current and future costs for lithium-ion batteries for use in electrified vehicle powertrains*. Duke University. Retrieved from http://dukespace.lib.duke.edu:8080/dspace/handle/10161/1007

Anderson, G., & Harrison, R. (2011). *Hybrid Distribution Trucks: Costs and Benefits*. Retrieved from http://swutc.tamu.edu/publications/technicalreports/476660-00080-1.pdf

Andress, D., Das, S., Joseck, F., & Dean Nguyen, T. (2011). Status of advanced light-duty transportation technologies in the US. *Energy Policy*, 1–17. doi:10.1016/j.enpol.2011.10.056

Andrews, R. J. (2011). *Couriers & Local Delivery Services in the US*. Retrieved from http://www.google.ca/url?sa=t&source=web&cd=1&ved=0CBcQFjAA&url=http%3A%2F%2Fwww.ibisworld.com%2Findustry%2Fdefault.aspx%3Findid%3D1950&ei=713-Tf6LNeXniALOw4XrBA&usg=AFQjCNH2V2sKZ3SEI8iEjli-RwgtNCOTeg&sig2=5N0c05SUZ3tlbF5r2wKTUg

Antich, M. (2010). Maintenance Costs Up Due to Frequency of Repair Increases. *Auto*. Automotive Fleet Magazine. Retrieved from http://www.automotive-fleet.com/Blog/Market-Trends/Story/2010/03/Maintenance-Costs-Up-Due-to-Frequency-of-Repair-Increases.aspx

Antich, M., Suizo, G., & Fletcher, L. (2010). Operating Costs Remain Flat in Calendar Year 2010. *Automotive Fleet Magazine*. Automotive Fleet Magazine. Retrieved from www.automotive-fleet.com/.../2010/.../Operating-Costs-Remain-Flat-in-Calendar-Year-2010.aspx

Argonne National Laboratory. (2009). Plug-Ins: The Future for Hybrid Electric Vehicles? Retrieved from http://www.transportation.anl.gov/pdfs/HV/376.pdf

Arrunada, B., & Vazquez, X. H. (2006). When your contract manufacturer becomes your competitor. *Harvard Business Review*, *84*(9), 135. Retrieved from http://www.arrunada.org/files/research/Arrunada Vazquez HBR 2006.pdf

Arts, G. (2007). *Analysis and synthesis of hybrid truck energy management*. Technische Universiteit Eindhoven. Retrieved from http://www.mate.tue.nl/mate/pdfs/8336.pdf

Ashley, S. (2011). Commercial Fleets Key to Heavy BEV Adoption. *SAE Truck & Bus Engineering Online*. Retrieved from http://www.sae.org/mags/TBE/9294 6/8/2011

Ashta, A., Bretones, F. D., & Tolle, L. (2007). Behavioral influences in Selecting Restructuring Strategies for Sick Companies. *The ICFAI Journal of Behavioral Finance*, (4), 7–31. Retrieved from http://granada.academia.edu/FranciscoDiazBretones/Papers/1010848/Behavioral_influences_in_Selecting_Restructuring_Strategies_for_Sick_Companies

Austin, D., Rosinski, N., Sauer, A., & le Duc, C. (2003). *Changing Drivers: The Impact of Climate Change on Competitiveness and Value Creation in the Automotive Industry*. World Resources Institute. Retrieved from http://www.wri.org/pubs/pubs_description.cfm?PubID=3873

AutoBeat Group. (2011). AutoBeat Group - 2011 Industry Outlook - A Slow But Steady Recovery. AutoBeat Group. Retrieved from http://www.autobeatgroup.com/wp-content/uploads/ABG-2011-Industry-Outlook.pdf

Automotive Fleet Magazine. (2006). Maintenance Statistics Medium Duty Market Data. *Automotive Fleet Magazine*, (December 2004), 48–49. Retrieved from http://www.google.ca/url?q=http://www.automotive-fleet.com/fc_resources/stats/AFFB06-48-49.pdf&sa=U&ei=kLRRTt-iLavViALfzLRz&ved=0CBIQFjAA&sig2=Ty5k_iQFJDA5HEnVZpDlrw&usg=AFQjCNF_RQxUNn0_lsca5yZxoUiJCpdLfQ

Automotive Fleet Magazine. (2009a). *Top 300 Commercial Fleets 2009*. *Automotive Fleet Magazine*. Bobit Business Media. Retrieved from http://www.fleet-central.com/TopFleets/pdf/top300_09.pdf

Automotive Fleet Magazine. (2009d). TOP 100 TRUCK FLEETS. *Automotive Fleet*, 27–28. Retrieved from http://www.fleet-central.com/TopFleets/pdf/top100_09.pdf

Automotive Fleet Magazine. (2009e). TOP 50 GREEN FLEETS. *Automotive Fleet Magazine*. Retrieved from http://www.fleet-central.com/TopFleets/pdf/top50green_09.pdf

Automotive Fleet Magazine. (2010a). Operating Costs 2009. *Automotive Fleet*. Retrieved from http://www.automotive-fleet.com/fc_resources/stats/AFFB10-36-opcost.pdf

Automotive Fleet Magazine. (2010b). GREEN FLEET: Scarcity of Data on Plug-in Electrics Makes Fleet Decision-Making Difficult. *Automotive Fleet*. Bobit Business Media. Retrieved from http://www.automotive-fleet.com/Channel/Green-Fleet/Article/Story/2010/10/Scarcity-of-Data-on-Plug-in-Electrics-Makes-Fleet-Decision-Making-Difficult.aspx

Automotive Fleet Magazine. (2010c). Top 300 Commercial Fleets 2010. *Automotive Fleet Magazine*. Retrieved from http://www.fleetfinancials.com/fc_resources/stats/FLT500top300.pdf

Automotive Fleet Magazine. (2011). Overall Fleet Car Maintenance Costs Remain Flat in 2010-CY. *Automotive Fleet*. Automotive Fleet Magazine. Retrieved from http://www.automotive-fleet.com/Article/Story/2011/03/Overall-Fleet-Car-Maintenance-Costs-Remain-Flat-in-2010-CY.aspx?interstitial=1

Avadikyan, A., & Llerena, P. (2010). A real options reasoning approach to hybrid vehicle investments. *Technological Forecasting and Social Change*, *77*(4), 649–661. doi:10.1016/j.techfore.2009.12.002

Axsen, J. (2006). *Combining stated and revealed choice research to inform energy system simulation models: The case of hybrid electric vehicles*. SIMON FRASER UNIVERSITY. Retrieved from http://www.emrg.sfu.ca/EMRGweb/pubarticles/PhD and Masters Thesis/699_Jaxsen_Final_1.pdf

Axsen, J., & Kurani, K. S. (2009). *Anticipating PHEV Energy Impacts in California*. Retrieved from http://escholarship.org/uc/item/88c6t0m3.pdf

Axsen, Jonn. (2007). *Consumer Preferences for Hybrid-Electric Vehicles: Understanding the Neighbor Effect* (pp. 1–18). Retrieved from http://steps.ucdavis.edu/People/jaxsen/Consumer Preferences for HEVs_Understanding the Neighbor Effect _2007.pdf

Axsen, Jonn, & Kurani, K. S. (2008). *The early US market for PHEVs: Anticipating consumer awareness, recharge potential, design priorities and energy impacts*. Retrieved from http://escholarship.org/uc/item/4491w7kf.pdf

Axsen, Jonn, Kurani, K. S., & Burke, A. (2010). Are batteries ready for plug-in hybrid buyers? *Transport Policy*, *17*(3), 173–182. doi:10.1016/j.tranpol.2010.01.004

Azure Dynamics. (n.d.). AC90 Motor with DMOC645 Controller Specifications Brochure.

Azure Dynamics. (2002). *Azure Dynamics Annual Report 2002*.

Azure Dynamics. (2004a). *Azure Dynamics Annual Report 2003*. Azure Dynamics Corporation.

Azure Dynamics. (2004b). *Azure Dynamics Annual Report 2004*. Retrieved from http://www.azuredynamics.com/investors/documents/2004_Annual_Report.pdf

Azure Dynamics. (2006a). *Azure Dynamics Short Form Prospectus - October 31, 2006*.

Azure Dynamics. (2006b). *Azure Dynamics Annual Report 2005* (Vol. 18). Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_AnnualReport2005.pdf

Azure Dynamics. (2007a). *Azure Dynamics Short Form Prospectus - October 15, 2007*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/shareholder-services/documents/ShortFormProspectusOct152007.pdf

Azure Dynamics. (2007b). *Azure Dynamics Annual Report 2007*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_2007_AnnualReport.pdf

Azure Dynamics. (2007c). *Azure Dynamics Annual Report 2006*. Retrieved from http://www.azuredynamics.com/investors/documents/2007_Annual_Report.pdf

Azure Dynamics. (2008b). *Investor Fact Sheet - May 2008*. Retrieved from http://www.azuredynamics.com/corporate/investor-relations/documents/AZDInvestorFactSheet_May08.pdf

Azure Dynamics. (2008c). *Azure Dynamics Management's Discussion And Analysis - March 31, 2008*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q1_2008.pdf

Azure Dynamics. (2008d). *Azure Dynamics Management's Discussion And Analysis - June 30, 2008*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q2_2008.pdf

Azure Dynamics. (2008e). *Azure Dynamics Management's Discussion And Analysis - September 30, 2008*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q3_2008.pdf

Azure Dynamics. (2008f). *Investor Fact Sheet - Fall 2008*. Retrieved from http://www.azuredynamics.com/corporate/investor-relations/documents/AZDInvestorFactSheet_September08.pdf

Azure Dynamics. (2008g). *Unaudited Interim Consolidated Financial Statements - March 31, 2008*. Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q1_2008.pdf

Azure Dynamics. (2008h). *Unaudited Interim Consolidated Financial Statements - June 30, 2008* (Vol. 2007). Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q2_2008.pdf

Azure Dynamics. (2008i). *Unaudited Interim Consolidated Financial Statements, September 30, 2008* (Vol. 2007). Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q3_2008.pdf

Azure Dynamics. (2008j). *Azure Dynamics Consolidated Financial Statements 2008*.

Azure Dynamics. (2009a). Azure Dynamics Investor Presentation Summer 2009. *Rodman & Renshaw Annual Global Conference*. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/corporate/investor-relations/documents/InvestorPresentation_September2009Rodman.pdf

Azure Dynamics. (2009b). *Investor Fact Sheet - Fall 2009*. Retrieved from http://www.azuredynamics.com/corporate/documents/AZDInvestorFactSheet_Fall09.pdf

Azure Dynamics. (2009d). *Azure Dynamics Management's Discussion and Analysis - December 31, 2008* (Vol. 2008). Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q4_2008.pdf

Azure Dynamics. (2009f). *Azure Dynamics Management's Discussion And Analysis - March 31, 2009*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q1_2009.pdf

Azure Dynamics. (2009g). *Azure Dynamics Management's Discussion And Analysis - June 30, 2009*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q2_2009.pdf

Azure Dynamics. (2009h). *Azure Dynamics Management's Discussion And Analysis - September 30, 2009*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q3_2009.pdf

Azure Dynamics. (2009i). MAN-080001-001 DMOC445 and DMOC645 User Manual. Azure Dynamics Corporation.

Azure Dynamics. (2009j). MAN-080003-001 DMOC CAN Controlled Application User Manual. Azure Dynamics Corporation.

Azure Dynamics. (2009k). *Annual Information Form 2008*. Retrieved from http://www.azuredynamics.com/investors/documents/2008_Annual_Information_Form.pdf

Azure Dynamics. (2009l). *Azure Dynamics Short Form Prospectus Dec 2009*. Azure Dynamics Corporation. Retrieved from http://www.sedar.com/GetFile.do?lang=EN&docClass=9&issuerNo=00004594&fileName=/csfsprod/data103/filings/01501395/00000010/C%3A%5CAK_Sedarf%5CA-C%5CA%5CAzure%5C2009NovPros%5CFinal%5CPros_EN2.pdf

Azure Dynamics. (2009m). *Unaudited Interim Consolidated Financial Statements - March 31, 2009* (Vol. 2008). Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q1_2009.pdf

Azure Dynamics. (2009n). MAN-080002-001 DMOC Pedal Controlled Application User Manual.

Azure Dynamics. (2009o). *Unaudited Interim Consolidated Financial Statements, June 30, 2009* (Vol. 2008). Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q2_2009.pdf

Azure Dynamics. (2009p). Azure Dynamics - 2009 Annual General Meeting Presentation. Azure Dynamics Corporation. Retrieved February 26, 2011, from http://www.azuredynamics.com/investors/documents/AGM_presentation_June2009.pdf

Azure Dynamics. (2009q). *Unaudited Interim Consolidated Financial Statements, September 30, 2009* (Vol. 2008). Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q3_2009.pdf

Azure Dynamics. (2009r). *Azure Dynamics Annual Report 2008*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_AnnualReport_2008.pdf

Azure Dynamics. (2010a). *Azure Dynamics Investor Presentation 2010 Q1 Financial Results*.

Azure Dynamics. (2010b). *Azure Dynamics Investor Presentation 2010 Q3 Financial Results*. Retrieved from http://www.azuredynamics.com/documents/AZDQ3_Webinar_Nov9_2010.pdf

Azure Dynamics. (2010c). *Azure Dynamics Investor Presentation 2010 Q2 Financial Results*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/AZDQ2_FinancialResults_08122010.pdf.pdf

Azure Dynamics. (2010d). *Investor Fact Sheet - Winter 2010*. Retrieved from http://www.azuredynamics.com/corporate/documents/AZD_InvestorFactSheet_winter2010.pdf

Azure Dynamics. (2010e). *Azure Dynamics 2010 Consolidated Financial Statements*. Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q4_2010.PDF

Azure Dynamics. (2010f). *Azure Dynamics Management's Discussion and Analysis - December 31, 2009* (Vol. 2009). Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q4_2009.pdf

Azure Dynamics. (2010g). *Investor Fact Sheet - Spring 2010*. Retrieved from http://www.azuredynamics.com/corporate/investor-relations/documents/AZD_InvestorFactSheet_spring2010.pdf

Azure Dynamics. (2010h). *Azure Dynamics Management's Discussion and Analysis - March 31, 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q1_2010.pdf

Azure Dynamics. (2010i). *Azure Dynamics Management's Discussion And Analysis - June 30, 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q2_2010.pdf

Azure Dynamics. (2010j). *Azure Dynamics - Patents*. Retrieved from http://www.azuredynamics.com/about-azd/documents/Patents_July2010.pdf

Azure Dynamics. (2010k). *Azure Dynamics Management's Discussion And Analysis - September 30, 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q3_2010.pdf

Azure Dynamics. (2010l). *Investor Fact Sheet - Fall 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/AZD_InvestorFactSheet_fall2010.pdf

Azure Dynamics. (2010m). AZD Force Drive Electric Drive Solutions - Brochure.

Azure Dynamics. (2010n). *Ontario's Green Commercial Vehicle Program (GCVP)*. Retrieved from http://www.azuredynamics.com/products/GCVPOnePager.pdf.pdf

Azure Dynamics. (2010o). *Annual Information Form 2009*. Retrieved from http://www.azuredynamics.com/investors/documents/2009_Annual_Information_Form.pdf

Azure Dynamics. (2010q). Press Release: Azure Dynamics Announces Third Quarter 2010 Results. Azure Dynamics Corporation. Retrieved February 26, 2011, from http://www.azuredynamics.com/documents/PR_Nov9_2010.pdf

Azure Dynamics. (2010r). Transit Connect Electric - Technical Presentation. Azure Dynamics Corporation. Retrieved December 7, 2010, from http://www.azuredynamics.com/investors/investor-relations/documents/TransitConnectElectric_TechnicalPresentation.pdf

Azure Dynamics. (2010s). MAN-080004-001 DC-DC Converter TVS-010022 User Manual. Azure Dynamics Corporation.

Azure Dynamics. (2010t). Azure Dynamics Corporation Instrument of Proxy - June 8, 2010. Azure Dynamics Corporation.

Azure Dynamics. (2010u). *Unaudited Interim Consolidated Financial Statements March 31, 2010*. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q1_2010.pdf

Azure Dynamics. (2010v). *Unaudited Interim Consolidated Financial Statements - June 30, 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q2_2010.pdf

Azure Dynamics. (2010w). *Azure Dynamics Annual Report 2009*. Retrieved from http://www.azuredynamics.com/corporate/investor-relations/documents/AZD_AnnualReport2009.pdf

Azure Dynamics. (2010x). *Unaudited Interim Consolidated Financial Statements - September 20, 2010*. Retrieved from http://www.azuredynamics.com/investors/documents/IFS_Q3_2010.pdf

Azure Dynamics. (2010y). *Azure Dynamics Annual Financial Statement 2009*. Azure Dynamics Corporation. Retrieved from http://www.sedar.com/DisplayCompanyDocuments.do?lang=EN&issuerNo=00004594

Azure Dynamics. (2010z). *Azure Dynamics Investor Presentation 2010 Annual General Meeting*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_AGM_June8_2010.pdf

Azure Dynamics. (2011a). Azure Dynamics To Begin Integrating Plug-In Hybrid Technology in. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/documents/PR_July27_2011.pdf

Azure Dynamics. (2011b). HERTZ ADDS FIVE TRANSIT CONNECT ELECTRIC VANS. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/investors/documents/PR_Oct17_2011.pdf

Azure Dynamics. (2011c). *Azure Dynamics Short Form Prospectus - October 25, 2011*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/shareholder-services/documents/ShortFormProspectusOct252011.pdf

Azure Dynamics. (2011d). Azure Dynamics Investor Presentation January 2011. Azure Dynamics Corporation. Retrieved January 29, 2011, from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_Jan2011_InvestorPresentation.pdf

Azure Dynamics. (2011e). Azure Dynamics ' California Customers Receive New Incentive Program for Deploying Transit Connect Electric. Azure Dynamics. Retrieved from http://www.azuredynamics.com/documents/PR_Oct27_2011.pdf

Azure Dynamics. (2011f). *Azure Dynamics 2010 Q4 Investor Presentation*. Retrieved from http://www.azuredynamics.com/investors/documents/AZDQ4_FinancialResults_03232011.pdf

Azure Dynamics. (2011g). *Azure Dynamics Announces US$5.0 Million Investment by Strategic Investor and Files a Preliminary Short Form Prospectus in Canada for an Offering of Common Shares and Warrants*. Retrieved from http://www.newswire.ca/en/story/865015/azure-dynamics-announces-us-5-0-million-investment-by-strategic-investor-and-files-a-preliminary-short-form-prospectus-in-canada-for-an-offering-of-co

Azure Dynamics. (2011h). *Azure Dynamics Short Form Prospectus February 4, 2011* (Vol. 85).

Azure Dynamics. (2011i). *Azure Dynamics - 2010 Annual Information Form*. Retrieved from http://www.azuredynamics.com/investors/documents/2010_Annual_Information_Form.pdf

Azure Dynamics. (2011j). *Azure Dynamics 2010 Management's Discussion and Analysis*.

Azure Dynamics. (2011k). Azure Dynamics Technology to Support DHL's All Green Fleet in Manhattan. Azure Dynamics Corporation. Retrieved April 13, 2011, from http://www.azuredynamics.com/documents/PR_April1_2011.pdf

Azure Dynamics. (2011l). Azure Dynamics ' California Customers Receive New Incentive Program for Deploying Transit Connect Electric. Azure Dynamics. Retrieved from http://www.prnewswire.com/news-releases/azure-dynamics-california-customers-receive-new-incentive-program-for-deploying-transit- connect-electric-132703053.html

Azure Dynamics. (2011m). *Azure Dynamics 2011 Q3 Investor Presentation*.

Azure Dynamics. (2011n). Ford Motor Company and Azure Dynamics Introduce Transit Connect Electric Wagon. Azure Dynamics. Retrieved from http://www.google.ca/url?q=http://www.azuredynamics.com/documents/PR_Nov16_2011.pdf&sa=U&ei=epTJTvjoFsSliQKX14m7Dw&ved=0CA8QFjAA&sig2=f5QrLsiT68SZ15ViqRp1PQ&usg=AFQjCNG0qeqXzmDMxZU3UHP65RbEehHazg

Azure Dynamics. (2011o). *Azure Dynamics 2Q2011 Financial Results*. Retrieved from http://www.azuredynamics.com/documents/2Q11Results.pdf

Azure Dynamics. (2011p). Azure Dynamics Announces Closing of US $5.0 Million Equity Investment by Strategic Investor – Johnson Controls. Azure Dynamics. Retrieved from http://www.azuredynamics.com/investors/documents/PR_Nov4_2011.pdf

Azure Dynamics. (2011q). Press Release: Azure Dynamics Receives Record 600 Unit Balance Hybrid Truck Order Via Its First Multi-year Contract With Purolator. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/investors/documents/PR_January17_2011.pdf

Azure Dynamics. (2011r). *Azure Dynamics Investor Presentation February 2011*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_Feb2011_InvestorPresentation.pdf

Azure Dynamics. (2011s). AZD - Clean Energy Vehicles for British Columbia. Azure Dynamics.

Azure Dynamics. (2011u). Azure Dynamics Management's Discussion And Analysis 3Q2011 - November 14, 2011. Azure Dynamics. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q3_2011.pdf

Azure Dynamics. (2011v). *Azure Dynamics 2011 Q1 Investor Presentation*.

Azure Dynamics. (2011w). *Azure Dynamics Short Form Prospectus November 11, 2011*. Retrieved from http://www.sedar.com/CheckCode.do;jsessionid=0000WdV8I04fW3iiaI_01kXJhHk:-1

Azure Dynamics. (2011x). Transit Connect Electric Receives GSA Contract Award. PR Newswire. Retrieved from http://www.prnewswire.com/news-releases/transit-connect-electric-receives-gsa-contract-award-123446554.html

Azure Dynamics. (2011y). Transit Connect Electric Receives GSA Contract Award. Azure Dynamics. Retrieved from http://www.azuredynamics.com/documents/PR_June8_2011.pdf

Azure Dynamics. (2011aa). *Unaudited Interim Consolidated Financial Statements - September 30, 2011*. Retrieved from http://www.azuredynamics.com/investors/documents/IFRS-FS_Q3_2011.pdf

Azure Dynamics. (2011ab). Azure Dynamics Announces 29 Transit Connect Electric Sales. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/investors/documents/PR_Dec12_2011.pdf

Azure Dynamics. (2011ac). *Investor Fact Sheet - Winter 2011*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/AZD_InvestorFactSheet_winter2011.pdf

Azure Dynamics. (2011ad). Azure Dynamics Management Discussion and Analysis Q1 2011. Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q1_2011.pdf

Azure Dynamics. (2011ae). *Azure Dynamics Management's Discussion and Analysis, Q2 2011* (pp. 1–16). Retrieved from http://www.azuredynamics.com/investors/documents/MDA_Q2_2011.pdf

Azure Dynamics. (2011af). Azure Dynamics Reports Record 2010 4th Quarter and Full Year Revenues - Press Release. Retrieved March 23, 2011, from http://www.azuredynamics.com/documents/Earnings_March23_2011.pdf

Azure Dynamics. (2011ag). *Azure Dynamics Investor Presentation June 2011*. Retrieved from http://www.azuredynamics.com/investors/investor-relations/documents/1Q11_Earnings_Call.pdf

Azure Dynamics. (2011ah). Azure Dynamics Reports Record 3rd Quarter 2011 Revenues - Press Release. Retrieved November 14, 2011, from http://www.azuredynamics.com/documents/PR_Nov14_2011.pdf

Azure Dynamics. (2012a). Azure Dynamics Enters Into Agreement to Sell its Patents. Retrieved from http://www.azuredynamics.com/investors/documents/PR_08082012.pdf

Azure Dynamics. (2012b). Azure Dynamics Announces Board of Directors Update. Retrieved April 26, 2012, from http://www.azuredynamics.com/documents/PR_April26_2012.pdf

Azure Dynamics. (2012c). Transit Connect Electric - Specifications & Ordering Guide. Retrieved April 1, 2012, from Transit Connect Electric - Specifications & Ordering Guide

Azure Dynamics, (2012f). Re: Companies' Creditors Arrangement Act and In the Matter of a Plan of Compromise or Arrangement of Azure Dynamics Corporation, Affidavit of Stephen Lee sworn on March 26, 2012

Azure Dynamics, (2012e). Re: Companies' Creditors Arrangement Act and In the Matter of a Plan of Compromise or Arrangement of Azure Dynamics Corporation, Affidavit of Stephen Lee sworn on April 18, 2012

BAE Systems. (2011). BAE Systems launches Hybridrive Green Parallel Propulsion System for Trucks at National Truck Equipment Association Work Truck Show. BAE Systems. Retrieved from http://www.baesystems.com/Newsroom/NewsReleases/autoGen_11128135140.html 3/9/2011

BC Hydro. (2010). *Charging Infrastructure*. Retrieved from http://www.bchydro.com/etc/medialib/internet/documents/environment/EVcharging_infrastructure_g

BC Research Inc. (1996). First Plug-in Hybrid in BC. BC Research Inc.

Bailey, D. (2010). Azure Dynamics looks to expand in medium trucks. *Reuters.com, Business & Financial News*. Reuters.com. Retrieved from http://www.reuters.com/article/2010/11/15/us-autos-summit-azuredynamics-idUKTRE6AE3XO20101115?type=companyNews

Balducci, P. (2008). *Plug-in Hybrid Electric Vehicle Market Penetration Scenarios*. Retrieved from http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17441.pdf

Bali, V., Insdorf, J., Lucks, G., Ostrander, C., Sakaki, S., & Stetler, L. (2009). *San Francisco Bay Area Clean Fleets Toolkit A Guide for On-Road Commercial Fleets*.

Ballot, E., Segrestin, B., & Weil, B. (2008a). Another look on product diversity: some new propositions to design profitable product ranges. *International Journal of Automotive Technology and Management*, *8*(1), 4–21. doi:10.1504/IJATM.2008.018765

Bandivadekar, A, Cheah, L., Evans, C., Groode, T., Heywood, J., Kasseris, E., Kromer, M., et al. (2008). Reducing the fuel use and greenhouse gas emissions of the US vehicle fleet. *Energy Policy*, *36*(7), 2754–2760. doi:10.1016/j.enpol.2008.03.029

Bandivadekar, A.P. (2004). *Combinations of policy measures with a high potential for reducing the fuel consumption of the US light-duty vehicle fleet*. Massachusetts Institute of Technology. Retrieved from http://esd.mit.edu/people/dissertations/bandivadekar.pdf

Bandivadekar, Anup, Bodek, K., Cheah, L., Evans, C., Groode, T., Heywood, J., Kasseris, E., et al. (2008). *On the road in 2035: Reducing transportation's petroleum consumption and GHG emissions* (Vol. 5). Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:On+the+Road+in+2035+-+Reducing+Transportation's+Petroleum+Consumption+and+GHG+Emissions#0

Bandivadekar, Anup P. (2008). *Evaluating the impact of advanced vehicle and fuel technologies in US light duty vehicle fleet*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/handle/1721.1/43856

Bansal, R. C. (2005). Electric Vehicles. In A. Emadi (Ed.), *Handbook of Automotive Power Electronics and Motor Drives*. CRC Press, Taylor and Francis Group LLC.

Baptista, P., Tomás, M., & Silva, C. (2010). Plug-in hybrid fuel cell vehicles market penetration scenarios. *International Journal of Hydrogen Energy*, *35*(18), 10024–10030. doi:10.1016/j.ijhydene.2010.01.086

Barker, B., & Hitchcock, D. (2003). Potential Emission Reductions of Diesel / Electric Hybrid Pickup / Delivery Vehicles in the Houston-Galveston Region. *Hybrid Truck Users Forum, San Antonio, Texas, October 23, 2003*. San Antonio, TX: Houston Advanced Research Center. Retrieved from Potential Emission Reductions of Diesel / Electric Hybrid Pickup / Delivery Vehicles in the Houston-Galveston Region

Barker, W. G. (2003). Baseline Class 4 Truck Inventory for the Houston-Galveston Region. *Fuel Cell*.

Barnett, B., Rempel, J., Ofer, D., Oh, B., Sriramulu, S., Sinha, J., Hastbacka, M., et al. (2010). *PHEV BATTERY COST ASSESSMENT,* Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2010/electrochemical_storage/es001_barnett_2010_o.pdf

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*(1), 99–120. doi:10.1177/014920639101700108

Barney, J. B. (1995). Looking inside for competitive advantage. *Academy of Management Executive*, *9*(4), 49–61.

Barnitt, R. (2010). *FedEx Gasoline Hybrid Electric Delivery Truck Evaluation : 6-Month Interim Report*.

Barnitt, R. (2011). *Twelve-Month Evaluation of FedEx Gasoline Hybrid Electric Delivery Trucks*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/48896.pdf

Barnitt, R. A., Brooker, A. D., & Ramroth, L. (2010). Model-Based Analysis of Electric Drive Options for Medium-Duty Parcel Delivery Vehicles Preprint. *25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition*. Shenzhen, China: US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.nrel.gov/vehiclesandfuels/vsa/pdfs/49253.pdf

Barnitt, R. A., Snyder, S., & Mancuso, J. (2011). Evaluation of Hybrid Electric Parcel Delivery Vehicles to Assess Drive Cycle Characteristics , Emissions and Fuel Economy. *SAE 2011 World Congress & Exhibition*. Detroit, MI: SAE International. Retrieved from http://papers.sae.org/2011-01-0879

Baron, J., Swiecki, B., & Chen, Y. (2006). Vehicle Technology Trends in Electronics for the North American Market: Opportunities for the Taiwanese Automotive Industry. *Center for Automotive Research, Ann Arbor*, (December). Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Vehicle+Technology+Trends+in+Electronics+for+the+North+American+Market:+Opportunities+for+the+Taiwanese+Automotive+Industry#0

Becker, T. A., Sidhu, I., & Tenderich, B. (2009). *Electric Vehicles in the United States: A New Model with Forecasts to 2030*. Retrieved from http://cet.berkeley.edu/dl/CET_Technical Brief_EconomicModel2030_f.pdf

Belzowski, B., & McManus, W. (2010). *Alternative powertrain strategies and fleet turnover in the 21st century*. University of Michigan, Ann Arbor, Transportation Research Institute. Retrieved from http://141.213.232.243/handle/2027.42/78001

Berggren, C., & Sushandoyo, D. (2010). Greening public transportation-a radical design and power train project at an incrementalist innovator. *International Journal of Automotive Technology and Management*, *10*(1). Retrieved from http://www.gerpisa.univ-evry.fr/rencontre/17.rencontre/GERPISAJune2009/Colloquium/Papers/S.02_Sushandoyo.pdf

Berman, Brad. (2011). British Columbia $ 5,000 Electric Vehicles Rebate Takes Effect. *PluginCars.com*. PluginCars.com. Retrieved from http://www.plugincars.com/british-columbia-offer-5000-electric-vehicles-point-sale-rebate-110567.html

Berman, Bradley. (2012, March 2). Tesla Battery Failures Make "Bricking" a Buzzword. *New York Times*, pp. 1–5. Retrieved from http://www.nytimes.com/2012/03/04/automobiles/Tesla-Battery-Failures-Make-Bricking-a-Buzzword.html

Bernhard, K. (2012). Kansas City Electric Vehicle Maker Looks To China For Investment Joint Venture. *Portfolio.com*. Retrieved from http://www.portfolio.com/views/blogs/money-hunt/2012/02/17/kansas-city-electric-vehicle-maker-looks-to-china-for-investment-joint-venture

Berthiaume, R., Joshi, B., Longdo, E., & Seshadri, V. (2007). Toyota Marketing Strategy for Plug-In Hybrids.

Bigazzi, A. Y., & Figliozzi, M. A. (2012). Congestion and Emissions Mitigation : A Comparison of Capacity , Demand , and Efficiency Based Strategies Forthcoming 2012 Transportation Research Part D, 1–20.

Bigelow, L. S., & Argyres, N. (2008). Transaction costs, industry experience and make-or-buy decisions in the population of early U.S. auto firms. *Journal of Economic Behavior & Organization*, *66*(3-4), 791–807. doi:10.1016/j.jebo.2006.01.010

Blackburn, J., Ford, J., & Khowailed, G. (2011). *A Comparative Study of Emerging Vehicle Technology Assessments*. Retrieved from http://info.ornl.gov/sites/publications/files/Pub27187.pdf

Blokvoord, R. A. G. (2010). *Sustainable and profitable growth in the automotive industry*. University of Twente. Retrieved from http://essay.utwente.nl/488/

Boardman, A., Shapiro, D., & Vining, A. (2004). A framework for comprehensive strategic analysis. *Journal of Strategic Management …*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.194.3983&rep=rep1&type=pdf

Boekestyn, A., Chew, E., Leigh, G., Mohanty, M., Pedder, S., & Swarup, T. (2009). *The Hybrids Report - 2009 Edition*. Retrieved from http://www.hybrid-ev.com/reports_endpoint.asp?id=29

Boesel, J. (2010). Fast Changing Directions in Drivetrains and Emissions. *DEER 2010 Conference*. Detroit, Michigan. Retrieved from http://www.google.ca/url?q=http://www1.eere.energy.gov/vehiclesandfuels/pdfs/deer_2010/tuesday/presentations/deer10_boesel.pdf&sa=U&ei=NUSuTsCvEMWtiALw_JTtCg&ved=0CBYQFjAA&sig2=UFaq8bE8LhmogUQeAXX42A&usg=AFQjCNHnqzF1AacB82eoaZg-E1pnmgFdgg

Bohlmann, B. (2007). Hybrid Hydraulic System Development for Commercial Vehicles. *SCAQMD Hydraulic Hybrid Forum, November 15, 2007*. Eaton Corporation. Retrieved from http://www.aqmd.gov/tao/conferencesworkshops/HydraulicHybridForum/BohlmannSlides.pdf

Bohr, B. (2011). Growing electro-mobility in a globally competitive environment. Robert Bosch GmbH, Automotive Group. Retrieved from http://archiv.iaa.de/2011/fileadmin/user_upload/2011/deutsch/downloads/fv/01/02-Growing_electro-mobility_in_a_globally_competitive_environment.pdf

Bolund, B., Bernhoff, H., & Leijon, M. (2007). Flywheel energy and power storage systems. *Renewable and Sustainable Energy Reviews*, *11*(2), 235–258. doi:10.1016/j.rser.2005.01.004

Bonoma, T. V., & Shapiro, B. P. (1983). *Segmenting the industrial market*. Lexington Books.

Book, M., Groll, M., Mosquet, X., Rizoulis, D., & Sticher, G. (2009). *The Comeback of the Electric Car: How Real, How Soon, and What Must Happen Next*. Boston Consulting Group. Retrieved from http://www.bcg.com/documents/file15404.pdf

Botsford, C., & Szczepanek, A. (2009). Fast Charging vs . Slow Charging : Pros and cons for the New Age of Electric Vehicles. *EVS24 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium*. Retrieved from http://www.cars21.com/files/news/EVS-24-3960315 Botsford.pdf

Bowles, P., Peng, H., & Zhang, X. (2002). Energy management in a parallel hybrid electric vehicle with a continuously variable transmission. *American Control Conference, 2000. Proceedings* *of the 2000*, *1*(6), 55–59. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=878771

Bowman, C. (2008). Generic strategies : a substitute for thinking? *The Ashridge Journal*, 1–6. Retrieved from http://www.ashridge.org.uk/Website/IC.nsf/wFARATT/Generic strategies: a substitute for thinking/$File/GenericStrategies.pdf

Bowman, C., & Ambrosini, V. (2003). How the Resource-based and the Dynamic Capability Views of the Firm Inform Corporate-level Strategy. *British Journal of Management*, *14*(4), 289–303. doi:10.1111/j.1467-8551.2003.00380.x

Bradley, R., & others. (2000). *Technology roadmap for the 21st century truck program: A Government-Industry Research Partnership, Report No. 21CT-001*. Retrieved from http://www.osti.gov/bridge/servlets/purl/777307-BKSUFs/native/

Bradley, T. H., & Quinn, C. W. (2010). Analysis of plug-in hybrid electric vehicle utility factors. *Journal of Power Sources*, *195*(16), 5399–5408. doi:10.1016/j.jpowsour.2010.02.082

Brewer, P. (2002). Putting strategy into the balanced scorecard. *Strategic Finance*, (January 2002), 44–52. Retrieved from http://www2.leuphana.de/umanagement/csm/content/nama/downloads/download_publikationen/FMA-2003_Articles_of_Merit.pdf

Britton, T. (2012). ROUNDTABLE - Business Turnaround - Is Your Business in Trouble. *Maine Ahead*. Retrieved from http://www.maineahead.com/roundtable%E2%80%93business-turnaround/

Brooke, L. (2009). Ripe For Innovation. *Automotive Engineering International Online*, 14–15. Retrieved from http://www.sae.org/mags/aei/6143 3/15/2012

Broussely, M. (1997). Lithium-ion batteries for electric vehicles: performances of 100 Ah cells. *Journal of Power Sources*, *68*(1), 8–12. doi:10.1016/S0378-7753(96)02544-X

Brown, S., Pyke, D., & Steenhof, P. (2010). Electric vehicles: The role and importance of standards in an emerging market. *Energy Policy*, *38*(7), 3797–3806. doi:10.1016/j.enpol.2010.02.059

Brownstone, D. (2000). Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. *Transportation Research Part B: Methodological*, *34*(5), 315–338. doi:10.1016/S0191-2615(99)00031-4

Bukszar, E. (2009). Strategic fit: Aligning organizational resources with strategy. *Western Decision Sciences Annual Conference Proceedings*. Kauai, Hawaii: Western Decision Sciences Institute. Retrieved from http://www.wdsinet.org/papers/

Bullis, B. K. (2007). Electric Cars 2.0. *Technology Review*, (october), 100–102.

Bunkley, N. (2012, March 2). GM Suspends Production of Chevrolet Volt - NYTimes.pdf. *New York Times*. Retrieved from http://www.nytimes.com/2012/03/03/business/gm-suspends-production-of-chevrolet-volt.html

Burgelman, R. A., & Grove, A. S. (2009). *The Drive Toward the Electric Mile: A Proposal for a Minimum Winning Game* (Vol. 2013). Graduate School of Business, Stanford University. Retrieved from http://gsbapps.stanford.edu/researchpapers/library/RP2013.pdf

Burke, A., & Miller, M. (2011). The power capability of ultracapacitors and lithium batteries for electric and hybrid vehicle applications. *Journal of Power Sources*, *196*(1), 514–522. doi:10.1016/j.jpowsour.2010.06.092

Business, M., & Arnold, E. (2012). FedEx Express adding more electric vehicles to fleet, (April 2011), 2011–2012.

Business Monitor International. (2011a). *UNITED STATES AUTOS REPORT Q2 2011*. Business Monitor International. Retrieved from http://www.businessmonitor.com/autos/us.html

Business Monitor International. (2011b). *CANADA AUTOS REPORT Q2 2011*. Business Monitor International. Retrieved from http://store.businessmonitor.com/autos/canada_autos_report

Business Tools and Templates. (2005). GE-McKinsey Matrix. Business Tools and Templates. Retrieved from http://www.business-tools-templates.com/U_GuidesPDF/General Electric GE McKinsey Matrix User Guide.pdf

Butterworth, C. (2010). *EU and NA Electric Buses, Vans and Trucks Market - Depot Based Delivery Vehicles expected to Account for 70 % of overall Electrification Share*. Frost & Sullivan. Retrieved from http://www.frost.com/prod/servlet/analyst-briefing-detail.pag?mode=open&sid=195829085

Buzzavo, L. (2008). Business strategies and key success factors for automotive retailers: the case of dealer groups in Italy. *International Journal of Automotive Technology and Management*, *8*(1), 105. doi:10.1504/IJATM.2008.018771

Buzzavo, L. (2011). Editorial: Special Issue on Automotive Marketing and Distribution in Europe. *Int. J. Automotive Technology and Management*, *8*(1), 1–3. Retrieved from http://www.inderscience.com/browse/getEditorial.php?articleID=1097

CALSTART. (2010a). *Energy Storage Compendium: Batteries for Electric and Hybrid Heavy Duty Vehicles*. Retrieved from http://www.calstart.org/Libraries/Publications/Energy_Storage_Compendium_2010.sflb.ashx

CALSTART. (2010b). *Saving Fuel , Saving Money : An Assessment of Fleet Cost Savings from High Efficiency Trucks*. Retrieved from http://calstart.org/Libraries/Publications/Saving_Fuel_Saving_Money_-_Final_Fleet_Report.sflb.ashx

CALSTART. (2010c). *Energy Storage Compendium: Batteries for Electric and Hybrid Heavy Duty Vehicles*. Retrieved from http://www.calstart.org/Libraries/Publications/Energy_Storage_Compendium_2010.sflb.ashx

Cairns, E. J. (2004). Batteries, Overview. *Encyclopedia of Energy* (Vol. 1, pp. 117–126). Elsevier. Retrieved from http://www.uns.ethz.ch/edu/teach/bachelor/energmob/Encycl-o-E_batteries_overview.pdf

CalCars News. (2005). DaimlerChrysler Describes Its PHEV Sprinter Van DaimlerChrysler Describes Its PHEV Sprinter Van Page 2 of 3. *CalCars.org*. Retrieved from http://www.calcars.org/calcars-news/83.html

Calendar, I., Edition, D., Company, O., & Us, C. (2012). Balance-Plus electrifies shuttle bus market, 5–7.

California Environmental Protection Agency Air Resources Board. (2011). Implementation Manual for the FY 2010-11 California Hybrid Truck and Bus Voucher Incentive Project. Retrieved from http://www.californiahvip.org/docs/hvip_implementationmanual_2011.pdf

California Air Resources Board. (2009a). *Initial Statement Of Reasons For Proposed Rulemaking For Plug-In Hybrid-Electric Vehicles: Amendments To Test Procedures And Aftermarket Parts Certification Requirements*. California Air Resources Board. Retrieved from http://www.arb.ca.gov/regact/2008/phev09/phev09.htm

California Air Resources Board. (2009b). *California Exhaust Emission Standards and Test Procedures for 2009 and subsequent Model Zero-Emission Vehicles, and Hybrid- Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes*.

California Air Resources Board. (2009c). *Summary of Staff's Preliminary Assessment of the Need for Revisions to the Zero Emission Vehicle Regulation*. Retrieved from www.arb.ca.gov/msprog/zevprog/2009zevreview/zevwhitepaper.pdf

California Air Resources Board. (2009d). *INITIAL STATEMENT OF REASONS FOR PROPOSED RULEMAKING FOR PLUG-IN HYBRID-ELECTRIC VEHICLES: AMENDMENTS TO TEST PROCEDURES AND AFTERMARKET PARTS CERTIFICATION REQUIREMENTS*. California Air Resources Board. Retrieved from http://www.arb.ca.gov/regact/2008/phev09/phev09.htm

California Air Resources Board. (2010a). *Final Draft implementation manual for the hybrid truck and bus voucher incentive project*. Retrieved from http://www.californiahvip.org/docs/HVIP_DraftImplementationManual.pdf

California Air Resources Board. (2010b). *FINAL DRAFT IMPLEMENTATION MANUAL FOR THE CALIFORNIA HYBRID TRUCK AND BUS*. Retrieved from http://www.californiahvip.org/docs/HVIP_DraftImplementationManual.pdf

California Air Resources Board. (2010c). *Draft Implementation Manual for the FY 2010-11 California Hybrid Truck and Bus Voucher Incentive Project (HVIP)*. Retrieved from http://www.californiahvip.org/docs/HVIP_DraftImplementationManual.pdf

California Air Resources Board. (2010d). *Attachment B: 2050 Greenhouse Gas Emissions Analysis: Staff Modeling in Support of the Zero Emission Vehicle Regulation*. California Air Resources Board. Retrieved from arb.ca.gov/msprog/zevprog/2009zevreview/2009zevreview.htm

California Air Resources Board. (2010e). *Attachment A: Status of ZEV Technology Commercialization*. Retrieved from www.arb.ca.gov/msprog/zevprog/2009zevreview/attachment_a_tsd.pdf

California Air Resources Board. (2011). ELIGIBLE VEHICLES - Hybrid Truck and Bus Voucher Incentive Project. California Air Resources Board. Retrieved from http://www.californiahvip.org/eligibleveh.asp 11/17/2011

California Plug-In Electric Vehicle Collaborative. (2010). *Taking Charge - Establishing California Leadership in the Plug-In Electric Vehicle Marketplace*. Retrieved from http://phev.ucdavis.edu/Taking_Charge_final2.pdf

Calstart. (2010). Hybrid Incentive Vouchers a Huge Success, Model for Others. *HTUF Dialog*. Calstart. Retrieved from http://www.calstart.org/Libraries/Hybrid_DiaLog_Archive/Hybrid_Dialog_10-1.sflb.ashx

Canis, B. (2011a). *Battery Manufacturing for Hybrid and Electric Vehicles : Policy Issues*. Retrieved from http://www.fas.org/sgp/crs/misc/R41709.pdf

Carlson, R. B., Duoba, M., Jehlik, F., Bohn, T., & Bocci, D. (2009). Advanced Vehicle Benchmarking of HEV ' s and PHEV ' s. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2009/vehicles_and_systems_simulation/vss_03_carlson.pdf

Carlsson, F., & Johansson-Stenman, O. (2000). *The Costs and Benefits of Electric Vehicles - Should battery, hybrid and fuel-cell vehicles be publicly supported in Sweden? Journal of Consumer Research* (Vol. 27). Retrieved from http://www.kfb.se/pdfer/R-00-46.pdf

Carr, H. (2011). *The Future of E-Mobility and Commercial Electrification*. *Global Power Report*.

Castonguay, S. (2010). *Canadian EV Industry*. Mexico City: Electric Mobility Canada. Retrieved from http://www.emc-mec.ca/files/CanadianEVIndustry-201010.pdf

Chan, C. C. (2002). The state of the art of electric and hybrid vehicles. *Proceedings of the IEEE*, *90*(2), 247–275. doi:10.1109/5.989873

Chanaron, J. J., & Teske, J. (2007). Hybrid Vehicles: a Temporary Step. *International Journal of Automotive Technology and Management*, *7*(4), 268–288. Retrieved from http://halshs.archives-ouvertes.fr/docs/00/20/73/92/DOC/Hybrid-Chanaron-Teske.doc

Cheah, L., & Heywood, J. (2010). The Cost of Vehicle Electrification: A Literature Review. *MIT Energy Initiative Symposium*, 2–6. Retrieved from http://web.mit.edu/sloan-auto-lab/research/beforeh2/files/PHEV costs.pdf

Chernova, Y. (2011). Battery Companies in Need of a Boost. *Wall Street Journal*. Retrieved from http://online.wsj.com/article/SB10001424052970204443404577051832763572816.html 12/6/2011

Chesser, P., Plague, B., & Firms, G. (2012). Taxpayers Take Hit as Layoffs, Bankruptcies Plague Green Firms. *FreeRepublic.com*. Retrieved from http://www.freerepublic.com/focus/f-bloggers/2838903/posts

Christensen, C. M., Suárez, F. F., Utterback, J. M., & Suarez, F. F. (2012). Strategies for Survival in Fast-Changing Industries, *44*(12).

Chu, A. (2002). Comparison of commercial supercapacitors and high-power lithium-ion batteries for power-assist applications in hybrid electric vehicles I. Initial characterization. *Journal of Power Sources*, *112*(1), 236–246. doi:10.1016/S0378-7753(02)00364-6

Chu, S., & Majumdar, A. (2012). Opportunities and challenges for a sustainable energy future. *Nature*, *488*(7411), 294–303. doi:10.1038/nature11475

Claflin, A. (2007). *Minnesota Plug-in Hybrid Electric Vehicle Task Force Report to the Minnesota Legislature* (pp. 1–28). Minnesota Pollution Control Agency. Retrieved from http://www.state.mn.us/mn/externalDocs/Commerce/PHEV_Task_Force_final_report_050707091959_PHEVTaskForceFinalReport.pdf

Clancy, H. (2011). Capacitors tapped to boost electric vehicle energy storage potential. *ZDnet.com GreenTech Pastures Blog*. Ziff-Davis. Retrieved from http://www.zdnet.com/blog/green/capacitors-tapped-to-boost-electric-vehicle-energy-storage-potential/16586

Cleary, T. P., McGill, R., Sikes, K. G., Hadley, S. W., Marano, V., Ungar, E., & Gross, T. (2010a). *Plug-In Hybrid Electric Vehicle Value Proposition Study*. Retrieved from http://www.afdc.energy.gov/afdc/pdfs/phev_study_final_report.pdf

Cleary, T. P., Sikes, K. G., & Lin, Z. (2010). *PHEV Market Introduction Study*. Retrieved from http://www.sentech.org/phev/pdfs/PHEV_Market_Introduction_Study_Report.pdf

Clevenger, J., Kelley, B., & McGraw, K. (2009). *Cost Analysis of Utilizing Electric Vehicles and Photovoltaic Solar Energy in the United States*. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA514205

Cobb, J. (2011). Plug-In Vehicle Industry Needs Fleet Sales. *Hybrid Cars*. HybridCars.com. Retrieved from http://www.hybridcars.com/news/plug-vehicle-indistry-places-hope-fleet-purchases-31072.html

Cole, J. (2010). Nissan Announces Next Vehicle in its Electric Lineup After LEAF : a LCV. Retrieved from http://nissan-leaf.net/2010/09/21/nissan-announces-next-vehicle-in-its-electric-lineup-after-leaf-a-lcv/

Committee on the Assessment of Technologies for Improving Light-Duty Fuel Economy. (2010). *Assessment of Fuel Economy Technologies for Light-Duty Vehicles*. National Academies Press, National Research Council. Retrieved from http://www.nap.edu/openbook.php?record_id=12924&page=R1

Condon, J. (2012). Mitusbishi to Add Light Truck Variant to Global EV Roll-outariant to Global EV Roll-out. *msn.com*, pp. 2011–2012. Retrieved from http://editorial.autos.msn.com/blogs/autosblogpost.aspx?post=12df1d1f-29c2-4d0a-9c39-06f3c9f1364f

Conley, P. J., & Hickman, J. (2008). *The Green Car Report* (pp. 78–90). MDB Capital Group. Retrieved from http://www.mdb.com/assets/files/MDB_GREEN CAR REPORT.pdf

Contestabile, M., Offer, G., Slade, R., & Jaegar, F. (2011). *Battery electric vehicles , hydrogen fuel cells and biofuels . Which will be the winner ?* Retrieved from http://workspace.imperial.ac.uk/icept/Public/Battery electric vehicles biofuels hydrogen fuel cell which will be the winner.pdf

Cooper, A., Furakawa, J., Lam, L., & Kellaway, M. (2009). The UltraBattery—A new battery design for a new beginning in hybrid electric vehicle energy storage☆. *Journal of Power Sources*, *188*(2), 642–649. doi:10.1016/j.jpowsour.2008.11.119

Cooper, C., Kamakaté, F., Reinhart, T., Kromer, M., & Wilson, R. (2009). *Reducing Heavy-Duty Long Haul Combination Truck Fuel Consumption and CO2 Emissions*. Retrieved from http://www.nescaum.org/documents/heavy-duty-truck-ghg_report_final-200910.pdf

Cooper, L. G. (2000). Strategic Marketing Planning for Radically New Products. *Journal of Marketing*, *64*(1), 1–16. doi:10.1509/jmkg.64.1.1.17987

Cotter, G. (2009). *A study in hybrid vehicle architectures: comparing efficiency and performance*. Massachusetts Institute of Technology. Retrieved from http://mit.dspace.org/bitstream/handle/1721.1/54531/565894813.pdf?sequence=1

County of Riverside Transportation Department. (2005). *Appendix : Truck Types and Classes - County of Riverside Truck Routing and Parking Study Report*. Retrieved from http://www.wrcog.cog.ca.us/downloads/050205 Truck Type Appendix.pdf

Cox, J., & Miyasato, M. (2011). Plug-In Hybrid Electric Medium Duty Commercial Fleet Demonstration and Evaluation. South Coast Air Quality Management District. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2011/veh_sys_sim/arr avt068_vss_miyasato_2011_o .pdf

Credit Suisse. (2009). *Electric Vehicles, Global Equity Research Report October 1, 2009* (pp. 1–127).

Cunningham, J. S. (2009). *An analysis of battery electric vehicle production projections*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/handle/1721.1/54532

DasGupta, R. (2011). Electrovaya's Low Cost , High Performance, Clean Manufacturing Approach for Lithium Ion Batteries. *2011 APEC SME Green Innovation Conference* (pp. 1–28). Seoul, Korea: Electrovaya Inc. Retrieved from http://www.apec-smeic.org/_file/seminar/2011/Canada.pdf

Datamonitor USA. (2009). *GLOBAL TOP 10 AUTOMOBILE COMPANIES — INDUSTRY , FINANCIAL AND SWOT ANALYSIS* (pp. 1–121).

Datamonitor USA. (2010a). *Light Trucks in the United States - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_the_united_states?productid=95D26C5F-C3B5-40D2-9879-AC3984B03BB5

Datamonitor USA. (2010b). *Medium & Heavy Trucks in the United States Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/medium_heavy_trucks_in_the_united_states?productid=BAF7608E-2B62-4890-AABB-8CD44FFBB97D

Datamonitor USA. (2010c). *Medium & Heavy Trucks in the United Kingdom - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/medium_heavy_trucks_in_the_united_kingdom?productid=7114500E-2417-49F2-A47D-AA6A1A3AFDC5

Datamonitor USA. (2010d). *Trucks in the United States - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/trucks_in_the_united_states?productid=1AC62588-6E9E-4F0B-873D-90D17A3A7DC5

Datamonitor USA. (2010f). *Medium & Heavy Trucks in Canada - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_canada?productid=7DC07EBB-0DC4-4002-9963-EF2F902F73D7

Datamonitor USA. (2010g). *Light Trucks in Canada - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_canada?productid=7DC07EBB-0DC4-4002-9963-EF2F902F73D7

Datamonitor USA. (2010h). *Light Trucks in Europe - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_europe?productid=8BBF8ADA-B48C-4F1C-9DCD-393A8DE2634A

Datamonitor USA. (2010i). *Medium & Heavy Trucks in Europe - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/medium_heavy_trucks_in_europe?productid=AA62851B-8FF6-45FC-939D-B022187CB735

Datamonitor USA. (2010j). *Trucks in Europe - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/trucks_in_europe?productid=46338E96-1D6A-4919-95CD-4871FB681B1B

Datamonitor USA. (2010k). *Medium & Heavy Trucks in Canada - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/medium_heavy_trucks_in_canada?productid=836814DA-860F-4366-A29E-9D9DD1D402F0

Datamonitor USA. (2010l). *Global Light Trucks - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/global_light_trucks?productid=F7824C9F-51EE-4FD5-B7CF-B14F721F474E

Datamonitor USA. (2010m). *Medium & Heavy Trucks in Mexico - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/medium_heavy_trucks_in_mexico?productid=AF26AB2B-220F-4EAA-AD78-3B335B9999B8

Datamonitor USA. (2010n). *Light Trucks in Mexico - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_mexico?productid=A3603E46-7E33-49E3-8F83-FD0D517E38AB

Datamonitor USA. (2010o). *Light Trucks in the United Kingdom - Industry Profile*. Retrieved from http://www.datamonitor.com/store/Product/light_trucks_in_the_united_kingdom?productid=D72B9A21-CA12-4AE0-B049-F88CEF746DBE

Datamonitor USA. (2011a). *Truck Manufacturing in Europe*. Retrieved from http://360.datamonitor.com.proxy.lib.sfu.ca/Product?pid=280E1BC4-5501-45B1-9A8A-51A9722471D2

Datamonitor USA. (2011b). *Global Top 10 Automobile Companies Report : Industry , Financial and SWOT Analysis*. Datamonitor USA. Retrieved from http://360.datamonitor.com.proxy.lib.sfu.ca/Product?pid=DMAU0408

Datamonitor USA. (2011c). *Truck Manufacturing in North America*. Datamonitor USA. Retrieved from http://360.datamonitor.com.proxy.lib.sfu.ca/Product?pid=03910351-2244-434C-8667-B5375704965E

Datta, Y. (1996). Market segmentation: an integrated framework. *Long Range Planning*, *29*(6), 797–811. doi:10.1016/S0024-6301(97)82817-8

Davidson, M. (2012). E-vehicle firms announce fleet contracts. *Boulder County Business Report*. Retrieved from http://www.bcbr.com/article.asp?id=61586

Davis, B. A., & Figliozzi, M. A. (n.d.). Evaluating the Cost and Environmental Implications of Commercial Electric Vehicles in the LTL Delivery Industry.

Davis, B. A., & Figliozzi, M. A. (2012a). A methodology to evaluate the competitiveness of electric delivery trucks. *TRANSPORTATION RESEARCH PART E*, *49*(1), 8–23. doi:10.1016/j.tre.2012.07.003

Davis, B. A., & Figliozzi, M. A. (2012b). THE COMPETITIVENESS OF COMMERCIAL ELECTRIC VEHICLES IN THE LTL DELIVERY INDUSTRY : *91st Annual Meeting of the Transportation Research Board January, 2012*. Retrieved from http://otrec.us/files/12-2676_TRB_Figliozzi.pdf

Davis, S. C., Diegel, S. W., & Boundy, R. G. (2010). *Transportation Energy Data Book: Edition 29, Report ORNL-6985*. Retrieved from http://cta.ornl.gov/data/tedb29/Edition29_Full_Doc.pdf

De Leenheer, P., Christiaens, S., & Meersman, R. (2010). Business semantics management: A case study for competency-centric HRM. *Computers in Industry*, *61*(8), 760–775. doi:10.1016/j.compind.2010.05.005

De Los Rios, A., & Nordstrom, K. (2011). *Building a business case for corporate fleets to adopt vehicle-to-grid technology (V2G) and participate in the regulation service market Master of Engineering in Logistics Massachusetts Institute of Technology Building a business case for corporate flee*. *Civil Engineering*. Massechusetts Institute of Technology.

De Los Ríos, A., Goentzel, J., Nordstrom, K., & Siegert, C. W. (2012). Economic Analysis of Vehicle-to-Grid (V2G) - Enabled Fleets Participating in the Regulation Service Market. *2012 IEEE PES Conference on Innovative Smart Grid Technologies* (pp. 1–8).

DeMorro, C. (2011). XL Hybrids Announces Customer Test Pilots for Bolt-on Hybrid Systems. *Gas2.org*. Gas2.org. Retrieved from http://gas2.org/2011/10/19/xl-hybrids-announces-customer-test-pilots-for-bolt-on-hybrid-systems/+XL+Hybrids+Announces+Customer+Test+Pilots+for+Bolt-on+Hybrid+Systems+Page

Decicco, J. M. (2004). Fuel Cell Vehicles. *Encyclopedia of Energy* (Vol. 2, pp. 759–770). Elsevier. Retrieved from http://www.uns.ethz.ch/edu/teach/bachelor/energmob/Encycl-o-E_fuel_cell_vehicles.pdf

Decicco, J. M. (2010). *A Fuel Efficiency Horizon for U.S. Automobiles*. Retrieved from http://energy.umich.edu/info/pdfs/Fuel Efficiency Horizon FINAL.pdf

Deloitte LLP. (2010). *Gaining traction: A customer view of electric vehicle mass adoption in the U. S. automotive market*. Retrieved from http://www.deloitte.com/view/en_US/us/Industries/Automotive-Manufacturing/c3b1a4c65c948210VgnVCM100000ba42f00aRCRD.htm

Deloitte LLP. (2011). *Unplugged: Electric vehicle realities versus consumer expectations*. Retrieved from http://www.deloitte.com/assets/Dcom-Global/Local Assets/Documents/Manufacturing/dttl_Unplugged_Global EV_09_21_11.pdf

Delorme, A., Pagerit, S., Sharer, P., & Rousseau, A. (2009). Cost Benefit Analysis of Advanced Powertrains from 2010 to 2045. *EVS24*, 1–12. Retrieved from http://www.transportation.anl.gov/pdfs/HV/566.pdf

Delta-Q Technologies. (2007). Chargers Integral to PHEV Success. *23rd International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Expo (EVS-23)*. Delta-Q Technologies. Retrieved from http://www.delta-q.com/white-papers/ChargersIntegraltoPHEVSuccess.pdf

Delucchi, M. (2005). AVCEM: Advanced Vehicle Cost and Energy Use Model. Overview of AVCEM, *17*(1). Retrieved from http://escholarship.org/uc/item/4vd6k48v.pdf

Delucchi, Mark, & Lipman, T. (2001). An Analysis of the Retail and Lifecycle Cost of Battery-Powered Electric Vehicles. *Transportation Research*. Retrieved from http://pubs.its.ucdavis.edu/publication_detail.php?id=391

Deveau, S. (2012). Financial Post Carmakers push limits of fuel efficiency. *Financial Post*. Retrieved from http://business.financialpost.com/2012/01/09/carmakers-push-limits-of-fuel-efficiency/

Diamond, D. (2008). The impact of government incentives for hybrid-electric vehicles: Evidence from US states. *Energy Policy*, *37*, 972–983. doi:10.1016/j.enpol.2008.09.094

Dijk, M., Orsato, R. J., & Kemp, R. (2012). The emergence of an electric mobility trajectory. *Energy Policy*, (2007). doi:10.1016/j.enpol.2012.04.024

Dinger, A., Martin, R., & Mosquet, X. (2008). *Batteries for Electric Cars - Challenges, Opportunities, and the Outlook to 2020*. Retrieved from http://www.bcg.com/documents/file36615.pdf

Divya, K. C., & Østergaard, J. (2009). *Battery energy storage technology for power systems—An overview* (Vol. 79, pp. 511–520). doi:10.1016/j.epsr.2008.09.017

Dixon, G. (2002). Purolator may convert to electric-powered trucks. *The Globe and Mail*. Retrieved from http://www.lexisnexis.com/hottopics/lnacademic/?verb=sr&csi=303830

Dizikes, P., Goentzel, J., & Siegert, C. (2012a). Driving the green. *Renewable Energy*, 11–12.

Duleep, G., Essen, H. van, Kampman, B., & Grünig, M. (2011). *Assessment of electric vehicle and battery technology*. *Assessment*. Retrieved from http://ec.europa.eu/clima/policies/transport/vehicles/docs/d2_en.pdf

Duleep, K. G. (2004). Internal Combustion Engine Vehicles. *Encyclopedia of Energy* (Vol. 3, pp. 497–513). Elsevier. Retrieved from http://www.uns.ethz.ch/edu/teach/bachelor/energmob/Encycl_Energy_2004_ICE_Vehicles.pdf

Dumitrache, A. (2011). Navistar eStar Electric Truck Joins Canada Post Fleet. *AutoEvolution*. Retrieved from http://www.autoevolution.com/news/navistar-estar-electric-truck-joins-canada-post-fleet-35001.html

Duoba, M. (2007). Evaluating PHEV Technology Using Component HIL, Subsystem, and Chassis Dynamometer Testing: Methods and Results. *SAE 2007 Hybrid Symposium*. Argonne National Laboratory.

Duvall, M. (2007). Plug-in Hybrid Vehicles - EPRI & Utility Perspective. *PHEV Grid Impacts Technical Review*. Electric Power Research Institute. Retrieved from http://www.smartgridnews.com/artman/uploads/1/EPRI_and_V2G.pdf

Duvall, M. S. (2005). Battery Evaluation for Plug-In Hybrid Electric Vehicles. *2005 IEEE Vehicle Power and Propulsion Conference*, 338–343. doi:10.1109/VPPC.2005.1554580

Duvall, Mark. (2005a). Batteries for Plug-In Hybrid Electric Vehicles. *SAE 2007 Hybrid Symposium* (Vol. 16, pp. 18–20). EPRI - Electric Power Research Institute.

Duvall, Mark. (2007). Plug-In Hybrid Electric Vehicles. *SAE 2007 Hybrid Symposium* (Vol. 16, pp. 18–20). SAE International.

Dyerson, R., & Pilkington, A. (2005). Gales of creative destruction and the opportunistic incumbent : The case of electric vehicles in California. *Technology Analysis & Strategic Management*, *17*(4), 391–408. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/09537320500357160

EV Update. (2011). Global : can electric trucks break out their niche? *evupdate.com*. Retrieved from http://analysis.evupdate.com/industry-insight/global-can-electric-trucks-break-out-their-niche>

Eaton Corporation. (2004). Eaton and Hybrid Electric Vehicle Powertrains- Past, Present, and Future, 1–6. Retrieved from http://www.roadranger.com/ecm/groups/public/@pub/@eaton/@roadranger/documents/content/rr_backgrounder.pdf

Eaton Corporation. (2009). Hybrid Solutions for MD Commercial Vehicles. *ERC Symposium*. Madison: University of Wisconsin. Retrieved from http://www.erc.wisc.edu/documents/symp09-Cornils.pdf

Eaton Hybrid Power Systems. (2012). Is hybrid power right for your vehicle, your route? Retrieved from http://www.roadranger.com/ecm/idcplg?IdcService=GET_FILE&dID=648151

Economist (2009). Mr. Ghosn bets the company. *Economist*. Retrieved from http://www.economist.com/node/14678942

Eggers, F., & Eggers, F. (2010). Where have all the flowers gone? Forecasting green trends in the automobile industry with a choice-based conjoint adoption model. *Technological Forecasting and Social Change*, 1–12. doi:10.1016/j.techfore.2010.06.014

Ehsani, M. (2010). Design and Control Methodology of Plug-in Hybrid Electric Vehicles. *IEEE Transactions on Industrial Electronics*, *57*(2), 633–640. doi:10.1109/TIE.2009.2027918

Ehsani, M., & Gao, Y. (2005). Hybrid Drivetrains. In A. Emadi (Ed.), *Handbook of Automotive Power Electronics and Motor Drives*. CRC Press, Taylor and Francis Group LLC.

Eklund, U., & Olsson, C. M. (2009). A Case Study of the Architecture Business Cycle for an In-Vehicle Software Architecture Electric & Electronic Systems Engineering. *European Conference on Software Architecture. WICSA/ECSA 2009*, 91–100. doi:10.1109/WICSA.2009.5290795

Electric & Hybrid Vehicle Technology. (2010, January). Audi E-tron. *Electric & Hybrid Vehicle Technology International*, (January).

Electric Cars Report. (2011). Mercedes-Benz Vito E-CELL Electric Van. *Electric Cars Report*. ElectricCarsReport.com. Retrieved February 28, 2011, from http://electriccarsreport.com/2010/07/mercedes-benz-vito-e-cell-electric-van/

Electric Drive Transportation Association. (2009). *The Electric Drive Road Map for Energy Security*. Retrieved from http://www.electricdrive.org/ht/a/GetDocumentAction/i/11212

Electric Mobility Canada. (2009). Hybrid and Electric Vehicle Incentives: A Canadian overview. Retrieved from http://www.emc-mec.ca/files/EMC-HybridElectricVehicleIncentivesCDNoverview.pdf

Electric Mobility Canada. (2010a). *Electric Vehicle Technology Roadmap for Canada*. Retrieved from http://www.emc-mec.ca/files/ElectricVehicleTechnologyRoadmapCanada-Feb2010.pdf

Electric Power Research Institute. (2007a). *Environmental Assessment of Plug-In Hybrid Electric Vehicles*. Electric Power Research Institute. Retrieved from http://my.epri.com/portal/server.pt?Abstract_id=000000000001016496

Electric Power Research Institute. (2007b). *Plug-In Hybrid Trouble Truck: An EPRI/Utility Alliance with Eaton Corporation and Ford Motor Company*. Retrieved from http://my.epri.com/portal/server.pt?Abstract_id=000000000001016496

Electrification Coalition. (2010a). *Electrification Roadmap: Revolutionizing transportation and achieving energy security*. Retrieved from http://www.electrificationcoalition.org/reports/EC-Roadmap-screen.pdf

Electrification Coalition. (2010b). *Fleet Electrification Roadmap - Revolutionizing Transportation and Achieving Energy Security*. Retrieved from http://www.electrificationcoalition.org/reports/EC-Fleet-Roadmap-screen.pdf

Elgowainy, A., Burnham, A., Wang, M., Molburg, J., & Rousseau, A. (2009). *Well-to-Wheels Energy Use and Greenhouse Gas Emissions Analysis of Plug-in Hybrid Electric Vehicles*.

Elmquist, M., de Paris, E. M., & Pohl, H. (2008). Managing eco-innovation in the automotive industry–the race towards electric vehicles. *The Dynamics of Institutions and Markets in Europe (DIME) Conference* (Vol. 1, pp. 1–22). Retrieved from http://www.r2ds-ile-de-france.com/IMG/pdf/Aggeri_Elmquist_Pohl_2008_DIME.pdf

EnergyEfficiencyNews.com. (2012). Obama launches challenge to get electric cars on the road. *EnergyEfficiencyNews.com*. Retrieved from http://www.energyefficiencynews.com/i/4926/ 3/9/2012

Enova Systems Inc. (2010). *Enova Systems, Inc 10-K Annual Report* (Vol. 15, pp. 1–63). Enova Systems Inc. Retrieved from http://www.sec.gov/Archives/edgar/data/922237/000095012310028787/f55335e10vk.htm

Enova Systems Inc. (2012a). Enova Systems 2011 Form 10-K.pdf. Enova Systems Inc. Retrieved from http://www.sec.gov/Archives/edgar/data/922237/000119312512140049/0001193125-12-140049-index.htm

Enova Systems Inc. (2012b). Freightliner Custom Chassis Corporation (FCCC) And Enova Partner To Unveil Green For Free Program. Retrieved from http://freightlinerchassis.com/component/option,com_servicecenters/ID,1140/UID,mollylee/controller,news/view,news/

Eskebæk, L., & Holst, J. (2009). *Electric vehicles on the Danish market in 2020*. Copenhagen Business School. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Electric+vehicles+on+the+Danish+market+in+2020#0

European Automobile Manufacturers Association (ACEA). (2009). *Definition of vehicle categories*. European Automobile Manufacturers Association - Association des

Constructeurs Européens d'Automobiles (ACEA). Retrieved from http://www.acea.be/images/uploads/rf/DEFINITION_OF_VEHICLE_CATEGORIES.pdf

Everly, S. (2012, September 3). Smith Electric scales back production goal, warns of cash crunch. *Kansas City Star*. Kansas City. Retrieved from http://www.kansascity.com/2012/09/03/3794953/smith-electric-scales-back-production.html

Fairley, P. (2008). Dark Clouds Over Clean Diesels. *IEEE Spectrum*, 1–3. Retrieved from http://spectrum.ieee.org/energy/fossil-fuels/dark-clouds-over-clean-diesels

Fairley, P. (2010). Will Electric Vehicles Finally Succeed ? *Technology Review*, (November/December 2010), 1–7. Retrieved from http://www.technologyreview.com/energy/26946/

Fairley, P. (2011a). Corporate Fleets : An Unlikely EV Engine. *Ieee Spectrum*. IEEE. Retrieved from http://spectrum.ieee.org/energywise/green-tech/advanced-cars/corporate-fleets-an-unlikely-ev-engine

Fairley, P. (2011b). Making Electric Vehicles Pay Off. *Technology Review*, (January/February 2011), 1–2. Retrieved from http://www.technologyreview.com/business/27007/?p1=BI

FedEx Express. (2011). FedEx Reports Vehicle Fleet Fuel Efficiency Goal Years Ahead of Schedule. Retrieved May 21, 2012, from http://www.utilityproducts.com/content/up/en/news/2012/05/21/fedex-reports-vehicle-fleet-fuel- efficiency-goal-years-ahead-of-schedule.html

Feeney, K., & AECOM Australia Pty Ltd. (2009). *Economic Viability of Electric Vehicles*. Retrieved from http://www.environment.nsw.gov.au/resources/climatechange/ElectricVehiclesReport.pdf

Fehrenbacher, K. (2012). Smith Electric Vehicles is raising $40M, what about IPO? *GigaOM*. Retrieved from http://gigaom.com/cleantech/smith-electric-vehicles-is-raising-40m-what-about-ipo/

Feng, W., & Figliozzi, M. (2012a). Impacts of Economic, Technological and Operational Factors on the Economic Competitiveness of Electric Commercial Vehicles in Fleet Replacement Decisions. *otrec.us*, *2011*(November 2011). Retrieved from http://otrec.us/files/12-2678_TRB_Figliozzi.pdf

Feng, W., & Figliozzi, M. (2012b). An Economic and Technological Analysis of the Key Factors Affecting the Competitiveness of Electric Commercial Vehicles : a case study from the USA market Forthcoming 2012 Transportation Research Part C, (503).

Fessler, D. (2011). 10 Electric Vehicle Trends to Watch in 2012. *InvestmentU*. InvestmentU.com. Retrieved from http://www.investmentu.com/2011/December/ten-ev-trends-watch-2012.html

Fildes, M., Nelson, S., Sener, N., Steiner, F., & Suntharasaj, P. (2007). Marketing Opportunity Analysis for Daimler Chrysler's Sprinter Van Plug-in Hybrid Electric Vehicle. *Management of Engineering and Technology, Portland International Center for* (pp. 1797–1810). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4349506

Fitzpatrick, N. (2007). Canadian Sponsored Plug-in Hybrids and Their Impact. *Plug-in Highway Network PHEV2007 Conference* (pp. 1–2). Winnipeg, Manitoba. Retrieved from http://www.electriccorvair.com/Documentation/PluginHwy_PHEV2007_PaperReviewed_Fitzpatrick.pdf

Fitzpatrick, N. (2008). Clean-energy transportation for eco-cities. *The IES Journal Part A: Civil & Structural Engineering*, *1*(3), 230–235. doi:10.1080/19373260802102433

Fleet, B. (2009). An Electric Highway – the Future of Green Transportation? *J. Env. Sci & Engineering (JESE)*, (Nov-Dec), 30–35.

Fleet, B., Li, J. K., & Gilbert, R. (2008). *Situational Analysis for the Current Status of the Electric Vehicle Industry*. Retrieved from http://richardgilbert.ca/Files/2008/Situational Analysis for the Current State of EV Technology.pdf

Fleet News. (2011a). Transit Connect Electric helps complete eco cycle. *Fleet News*. Retrieved from http://www.fleetnews.co.uk/news/2011/10/28/transit-connect-electric-helps-complete-eco-cycle/41122/

Fleet News. (2011b). Nissan and Fedex express test NV200- based electric vehicle. *FleetNews*. Retrieved from http://www.fleetnews.co.uk/news/2011/12/14/nissan-and-fedex-express-test-nv200-based-electric-vehicle/41825/

Fleet Vans & Trucks Magazine. (2009). Fleet Vans & Trucks Magazine. *Fleet Vans & Trucks*, (May).

Fleets & Fuels ShowTimes. (2010). Too Much Too Soon? *Fleets & Fuels ShowTimes Magazine*. Fleets & Fuels ShowTimes Magazine. Retrieved from http://showtimesdaily.com/news-articles/too-much-too-soon 10/10/2010

Ford Corporation. (2010). Ford Transit Van: eBrochure and specification. Ford Corporation (UK). Retrieved from http://www.newfordtransit.co.uk/transit_brochures/transitebrochure.pdf

Ford Corporation. (2011). Azure Ford Transit Connect Electric 2012. *Ford 2012 Fleet Preview Guide*. Ford Corporation. Retrieved from http://media.ford.com/images/10031/TC_Electric_Highlights.pdf

Freightliner Custom Chassis Corporation. (2011). MT-45 Series Chassis - Brochure. Freightliner Custom Chassis Corporation. Retrieved from http://freightlinerchassis.com/documents/MT-45_Update_Flyer 02-24-11-20110225115023000000.pdf

Friedman, D. (2003). *A New Road: The Technology and Potential of Hybrid Vehicles*. Retrieved from http://www.ucsusa.org/assets/documents/clean_vehicles/hybrid2003_final.pdf

Frost & Sullivan. (2007). *Global Market Analysis of Plug in Hybrid Electric Vehicles*. Frost & Sullivan. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M12D-01-00-00-00

Frost & Sullivan. (2008a). *The Global Oil Paradox, Transforming the Automotive Industry: Strategic Assessment of the Global Alternative Powertrain Market*. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M24D-01-00-00-00

Frost & Sullivan. (2008b). *Strategic Assessment of European Passenger Electric Vehicles Market*. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M24D-01-00-00-00

Frost & Sullivan. (2008c). *The Global Oil Paradox, Transforming the Automotive Industry: Strategic Assessment of the Global Alternative Powertrain Market*. Retrieved from http://awbriefing.com/presentations/211008_anil_valsan.pdf

Frost & Sullivan. (2009a). *North American Class 6-8 Truck Hybrid Powertrain Systems Market*. *Chart* (pp. 2–1 to 2–6). Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=N37A-01-00-00-00

Frost & Sullivan. (2009b). *Electric Vehicles Unplugged: A 360 Degree Vision of the Future*.

Frost & Sullivan. (2009c). *New Business Models for Electric Vehicles: Perspective from Frost & Sullivan, GM, Peugeot Citroen and Think's Senior Executives*. Retrieved from http://www.frost.com/prod/servlet/analyst-briefing-detail.pag?mode=open&sid=185986092

Frost & Sullivan. (2009d). *New Business Models for Electric Vehicles: Perspective from Frost & Sullivan, GM, Peugeot Citroen and Think's Senior Executives*. Retrieved from http://www.frost.com/prod/servlet/analyst-briefing-detail.pag?mode=open&sid=185986092

Frost & Sullivan. (2009e). Government Support Critical for Powering the Electric Vehicle Market. Frost & Sullivan Corporate Communications.

Frost & Sullivan. (2010a). *Summary of Frost & Sullivan ' s Electric Vehicles Research Programme – Providing a 360 overview for all major stake holders*. Frost & Sullivan, Global Electric Vehicle Program. Retrieved from http://gil-global.com/electricvehicle/images/F&S EV Expertise and Research Agenda.pdf

Frost & Sullivan. (2010b). *360 Degree Perspective of the Global Electric Vehicle Market – 2010 Edition*. Frost & Sullivan. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M5B7-01-00-00-00

Fröberg, J., Sandström, K., & Norström, C. (2005). Business situation reflected in automotive electronic architectures: analysis of four commercial cases. *ACM SIGSOFT Software Engineering Notes*, *30*(4), 1–6. Retrieved from http://portal.acm.org/citation.cfm?id=1082983.1083197

Fueleconomy.gov. (2011). 2012 Transit Connect Electric Fuel Economy. US Department of Energy - Energy Efficiency & Renewable Energy. Retrieved from http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=31893 11/30/2011

GBI Research. (2010). Hybrid Truck Market Analysis to 2020 - Favorable Regulations and Fleet Purchases to Buoy the North American Market. GBI Research. Retrieved from http://reportsnreports.wordpress.com/2010/07/05/hybrid-truck-market-analysis-to-2020-f... 10/28/2010

GMotors.ie. (2010). Opel to debut Vivaro e-Concept at the IAA Commercial Vehicles Fair. Retrieved from http://www.gmotors.ie/blog/opel-to-debut-vivaro-e-concept-at-the-iaa-commercial-vehicles-fair/

Gabel, D. A. (2012). The Future of Trucking is Electric. *ENN.Com*. Retrieved from http://www.enn.com/business/article/43967

Gaillac, L. (2006). SPRINTER PHEV Battery Testing Project. *Electric Power Research Institute EV Forum 2006*. Southern California Edison. Retrieved from http://www.aqmd.gov/tao/ConferencesWorkshops/PHEV_Forum-07-12-06/8-LoicGaillac-EPRI-revised.pdf

Gaillard, C. L. (2005). *An Analysis of the Impact of Modularization and Standardization of Vehicles Electronics Architecture on the Automotive Industry*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/handle/1721.1/34674

Gallon, S. (2009). Who Will Buy Tomorrow's Electric Vehicles. R.L. Polk. Retrieved from http://www.polk.com/TL/PV-200909-Issue015-ElectricVehicles.pdf

Gallucci, M. (2012). Auto Industry Pins Hopes on Fleets to Charge America ' s Electric Car Market. *InsideClimate News*. InsideClimate News. Retrieved from http://insideclimatenews.org/news/20110911/auto-industry-nissan-leaf-chevy-volt-fleet-operators-fedex-electric-cars-charging

Garthwaite, J. (2009). Why Ford & Smith Electric Have Called It Quits on Electric Van Partnership. Retrieved from http://gigaom.com/cleantech/why-ford-smith-electric-have-called-it-quits-on-electric-van-partnership/

Garthwaite, J. (2010). Ford to Follow GM in Making Plug-in Battery Cells Overseas. Retrieved from http://gigaom.com/cleantech/ford-to-follow-gm-in-making-plug-in-battery-cells-overseas/

Garthwaite, J. (2011). Tale of Two Electric Truck Makers : Smith and Modec. *GigaOM*. Retrieved from http://gigaom.com/cleantech/tale-of-two-electric-truck-makers-smith-and-modec/#comment-611440

Gelsi, S. (2012). Energy chief sees potential for electric cars. *Marketwatch.com*. Retrieved April 11, 2012, from http://articles.marketwatch.com/2012-04-11/industries/31323546_1_electric-cars-natural-gas-gasoline-powered-cars

Gereffi, G., Trigg, T., & Lowe, M. (2010). *Case Study : A123 Systems Local Markets and Competitiveness A Value Chain Analysis*. Center on Globalization, Governance & Competitiveness (CGGC), Duke University. Retrieved from http://www.cggc.duke.edu/pdfs/CGGC_A123_CaseStudy_10-22-10.pdf

German, J. M. (2004). Hybrid Electric Vehicles. *Encyclopedia of Energy* (Vol. 3, pp. 197–213). Elsevier.

Goebel, D. (2009). The Future of the U.S. Commercial Vehicle Market, (July), 1–2. Retrieved from http://www.polk.com/KC/PV_200907_Issue010_CVMkt.pdf

Golbuff, S. (2006). *Optimization of a plug-in hybrid electric vehicle*. Georgia Institute of Technology. Retrieved from http://etd.gatech.edu/theses/available/etd-05172006-183243/

Goldman Sachs. (2010). *Americas: Clean Energy: Energy Storage - Advanced Batteries: Light, but the tunnel is long*. Retrieved from http://www.voxone.com/eos/articles/GSBatteryReport2010-06-29.pdf

Golob, T. F., Torous, J., & Bradley David, M. (1997). Commercial fleet demand for alternative-fuel vehicles in California 1. *Transportation Research Part A: Policy and Practice*, *31*(3), 219–233. doi:10.1016/S0965-8564(96)00017-1

Golob, T. F., Torous, J., & Bradley, M. (2002). *Commercial Fleet Demand for Alternative-fuel Vehicles*. University of California Transportation Center, University of California. Retrieved from http://128.200.36.2/its/publications/papers/ITS/UCI-ITS-WP-96-5.pdf

Gonder, J., & Markel, T. (2007). Energy Management Strategies for Plug-In Hybrid Electric Vehicles Distance. *2007 SAE World Congress*. SAE International. Retrieved from http://www.google.ca/url?q=http://www.nrel.gov/vehiclesandfuels/vsa/pdfs/40970.pdf&sa=U&ei=qbNRTsOWLpLZiALfibV4&ved=0CBYQFjAA&sig2=xwIvglTHbbLMb_zvoOurcQ&usg=AFQjCNGb4XQaZ7w8S_swwwNO5dJq6QjKzw

González, C. J. I., Ogliari, A., & Back, N. (2008). Systematization of technology roadmapping. *Product: Management & Development*, *6*(2), 77–97. Retrieved from http://pmd.hostcentral.com.br/revistas/vol_06/nr_2/v6n2a6201.pdf

Gooderham, M. (2011). Trucking on and lowering emissions. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/report-on-business/managing/top-employers/green-employers/trucking-on-and-lowering-emissions/article1998047/page2/

Gorzelany, J. (2012, May). Nissan's Second All-Electric Vehicle Will (Literally) Deliver The Goods. *Forbes*. Retrieved from http://www.forbes.com/sites/jimgorzelany/2012/05/23/nissan-to-build-all-electric-delivery-vehicle/

Gover, J. E., Thompson, M. G., & Hoff, C. J. (2010). Program Based on Corporate Needs. *IEEE Vehicle Power and Propulsion Conference (VPPC) 2010*. Flint, MI: IEEE Institute of Electrical and Electronics Engineers. doi:10.1109/VPPC.2010.5729246

Gover, J., & Harris, R. L. (2009). Global Automotive Sector - Strengthening the Competitiveness of U.S. Auto Firms. *IEEE VEHICULAR TECHNOLOGY MAGAZINE*, (December), 85–89. Retrieved from http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=5338999

Government Fleet. (2011). Funding Available for California Hybrid & Electric Buses / Trucks. *Government-Fleet.com*. Bobit Business Media. Retrieved from http://www.google.ca/url?q=http://www.government-fleet.com/News/Story/2011/10/Funding-Available-for-California-Hybrid-Electric-Buses-Trucks.aspx&sa=U&ei=Bt2tTuH6BcjQiAKipZmACw&ved=0CBcQFjAA&sig2=oIgwtwaotNOTujWrQqUUYw&usg=AFQjCNGqNwqhuQHBFt_9cS25Az257HZYjg

Grant, R. M. (2008). *Contemporary Strategy Analysis* (pp. 143–158).

Green Car Congress. (2010a). In-Wheel Electric Drive Company Names EV Industry Veteran Bob Purcell Chairman and CEO. Retrieved from http://www.greencarcongress.com/2010/10/protean-20101006.html

Green Car Congress. (2010b). Mitsubishi Motors and Yamato Field Testing Prototype Electric Delivery Van. *Green Car Congress*. Green Car Congress. Retrieved from http://www.greencarcongress.com/2010/10/yamatao-20101017.html 1/26/2011

Green Fleet Magazine. (2011a). What is the Future of All-Electric Medium-Duty Trucks? *Green Fleet Magazine*. Bobit Business Media. Retrieved from http://www.greenfleetmagazine.com/article/50689/what-is-the-future-of-all-electric-medium-duty-trucks

Green Fleet Magazine. (2011b). Hybrid Truck Project Launches in Southern California. Green Fleet Magazine. Retrieved from http://www.greenfleetmagazine.com/print/50855

GreenCarSite. (2012). Introduction to Green Vans. *GreenCarSite.co.uk*. Retrieved March 26, 2012, from http://www.greencarsite.co.uk/green-commercial-vehicles.htm

Greenberg, D. (2010). Plug-In electric Vehicles for Fleets. *E Source Energy Managers' Quarterly*. E Source Companies LLC. Retrieved from http://www.touchstoneenergy.com/efficiency/bea/Documents/Plug-InElectricVehiclesforFleets.pdf

Greene, D. L., Duleep, K., & McManus, W. (2004). *Future potential of hybrid and diesel powertrains in the US light-duty vehicle market*. Oak Ridge National Laboratory, Oak Ridge, Tennessee. Retrieved from http://deepblue.lib.umich.edu/handle/2027.42/64891

Grizzle, J. W. (2003). Power management strategy for a parallel hybrid electric truck. *IEEE Transactions on Control Systems Technology*, *11*(6), 839–849. doi:10.1109/TCST.2003.815606

Hadjipaschalis, I., Poullikkas, A., & Efthimiou, V. (2009). Overview of current and future energy storage technologies for electric power applications. *Renewable and Sustainable Energy Reviews*, *13*(6-7), 1513–1522. doi:10.1016/j.rser.2008.09.028

Hamel, C. K. P. G. (1990). The Core Competence of the Corporation.

Hansen, K., Mathiesen, B. V., & Connolly, D. (2011). *Technology and implementation of electric vehicles and plug-in hybrid electric vehicles*. Retrieved from http://vbn.aau.dk/files/58766708/attachment_6.ashx.pdf

Hart, L. A. (2009). The Original Solectria Sunrise. Retrieved February 26, 2011, from http://www.sunrise-ev.com/original.htm 11/6/2010

Hase, Y. (2007). *Automotive electronics business*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/bitstream/handle/1721.1/39526/173993102.pdf?sequence=1

Hekkert, M., & van Den Hoed, R. (2004). Competing technologies and the struggle towards a new dominant design: the emergence of the hybrid vehicle at the expense of the fuel cell vehicle? *Greener Management International*, *47*, 29. Retrieved from http://www.uu.nl/uupublish/content/5.pdf

Hidalgo & DeVries, I., & Frances Kernodle Associates, I. (2007). *An Evaluation of the Market for Small-to-Medium-Sized Cutaway Buses*. *Transportation*. Retrieved from http://www.fta.dot.gov/documents/AnEvaluationofMarketforSmalltoMediumSizedCutawayBuses.pdf

Hill, D. M., Agarwal, A. S., & Ayello, F. (2011). Fleet operator risks for using fleets for V2G regulation. *Energy Policy*, 1–11. doi:10.1016/j.enpol.2011.10.040

Hlavacek, J.D., & Ames, B. C. (1986). Segmenting industrial and high-tech markets. *Journal of Business Strategy*, *7*(2), 39–50. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1706276&show=abstract

Hlavacek, J.D., & Reddy, N. M. (1993). Identifying and qualifying industrial market segments. *Marketing Intelligence & Planning*, *3*(1), 41–56. Retrieved from http://www.emeraldinsight.com/journals.htm?articleid=1665028&show=abstract

Hodgins, B. (2004). Westport and CWI : Engine Market Analysis Update. *Natural Gas Vehicle Technology Forum Technical Committee Meeting Presentations 2004*. US Department of

Energy - Energy Efficiency & Renewable Energy. Retrieved from http://www1.eere.energy.gov/cleancities/pdfs/cwi_market_ngvtf_sac.pdf

Hofstetter, D. (2011a). All Your Forecasts are Wrong : How Many EVs Will Be On the Road by 2015? GTM Research. Retrieved from http://www.greentechmedia.com/articles/read/does-it-matter-how-many-evs-will-be-on-the-road-by-2015/

Hofstetter, D. (2011b). EVs and Total Cost of Ownership: Should Consumers Pay Upfront Today for Electrons Tomorrow ? *October*. GTM Research. Retrieved from http://www.greentechmedia.com/articles/read/total-cost-of-ownership/

Hofstetter, D. (2011c). Demystifying Electric Vehicles , From Market Adoption to Distributed Storage. GTM Research. Retrieved from http://www.greentechmedia.com/articles/read/the-electric-vehicle-market-demystified/

Hofstetter, D. (2011d). BEVs vs. PHEVs : Peaceful Coexistence or Life-or-Death Battle. GTM Research. Retrieved from http://www.greentechmedia.com/articles/read/bevs-vs.-phevs-peaceful-coexistence-or-life-or-death-battle/

Hollinshead, M. J., Eastman, C. D., & Etsell, T. H. (2005). Forecasting performance and market penetration of fuel cells in transportation. *Fuel Cells Bulletin*, *2005*(12), 10–17. Retrieved from http://www.sciencedirect.com/science/article/pii/S1464285905708671

Holmes, J. (2012). Ford Transit Connect Electric Drivetrain Manufacturer Files for Bankruptcy. *Motor Trend*. Retrieved from http://wot.motortrend.com/ford-transit-connect-electric-drivetrain-manufacturer-files-for-bankruptcy-184979.html

Hurst, D. (2010). Pike Research Forecasts 300,000 Medium- and Heavy-Duty Hybrid Trucks and Buses Worldwide by 2015 ; 63 % CAGR. Green Car Congress. Retrieved from http://www.pikeresearch.com/newsroom/300000-hybrid-trucks-and-buses-to-be-on-the-road-by-2015

Hurst, D., & Wheelock, C. (2010a). *Battery Electric and Plug-in Hybrid Electric Vehicles : OEM Strategies , Demand Drivers , Technology Issues, Key Industry Players , and Global Market Forecasts*. Pike Research.

Hurst, D., & Wheelock, C. (2010b). *Hybrid Trucks and Buses Medium and Heavy Duty Commercial Truck Markets for Hybrid, Plug-in Hybrid, and Battery Electric Drives*. Retrieved from http://www.pikeresearch.com/wordpress/wp-content/uploads/2010/06/HTB-10-Executive-Summary.pdf

Hybrid Electric Vehicle Progress Magazine. (2007). General Motors Chairman and CEO Rick Wagoner Describes GM ' s Commitment to Energy Diversity with E-Flex Family. *Hybrid & Electric Vehicle Progress*. Retrieved from http://www.hybridconsortium.org/blog/GM_eFlex.pdf

IBISWorld. (2010a). *Postal Service in the US*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=1216

IBISWorld. (2010b). *Global Automobile and Light Duty Motor Vehicle Manufacturing : C2531-GL*. Retrieved from http://retail.ibisworld.com/globalindustry/default.aspx?indid=1000&rcid=0

IBISWorld. (2010c). *Global Sale of Motor Vehicles : F4111-GL*. Retrieved from http://www.ibisworld.com/globalindustry/default.aspx?indid=1320

IBISWorld. (2010d). *Global Logistics - Air Freight : H4832-GL*. Retrieved from http://www.ibisworld.com/globalindustry/default.aspx?indid=1570

IBISWorld. (2010e). *Global Logistics - Couriers : H4921-GL*.

IBISWorld. (2010f). *Global Logistics - Air Freight : H4832-GL*. Retrieved from http://www.ibisworld.com/globalindustry/default.aspx?indid=1570

IBISWorld. (2011a). *Local Freight Trucking in the US - April 2011*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=1149

IBISWorld. (2011b). *Long-Distance Freight Trucking*. IBISWorld Inc. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=1150

IBISWorld. (2011c). *Local Specialized Freight Trucking in the US - January 2011*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=1155

IBISWorld. (2011d). *Global Heavy Duty Truck Manufacturing : C2532-GL*. IBISWorld Inc. Retrieved from http://retail.ibisworld.com/globalindustry/default.aspx?indid=1002&rcid=0

IBISWorld. (2011e). *Global Motor Vehicle Engine and Engine Parts Manufacturing : C2533-GL*. Retrieved from http://www.ibisworld.com/globalindustry/default.aspx/indid/1004

IBISWorld. (2011f). *Local Freight Trucking in the US*. IBISWorld Inc. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=1150

IBISWorld. (2011g). *Electric Power Transmission , Control & Distribution in the US*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=155

IBISWorld. (2011h). *Battery Manufacturing in the US*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=801

IBISWorld. (2011i). *Truck & Bus Manufacturing in the US*. Retrieved from http://www.ibisworld.com/industry/default.aspx?indid=818

IBISWorld. (2011j). *Automobile Electric and Electronics Manufacturing in the US*. Retrieved from http://www.alacrastore.com/storecontent/IBISWorld_Industry_Market_Research-Automobile_Electric_Electronics_Manufacturing_in_the_US-2042-873

IDTechEx Ltd. (2012). Industrial and Commercial Electric Vehicles 2012-2022. *FleetNews*. IDTechEx Ltd. Retrieved from http://www.fleetnews.co.uk/news/2011/10/28/transit-connect-electric-helps-complete-eco-cycle/41122/

IHS Global Insight Automotive Group. (2011a). IHS Automotive Global Production Summary. IHS Inc.

IHS Global Insight Automotive Group. (2011b). *Automotive Production Barometer*. Retrieved from http://www.ihs.com/en/ca/Images/CSM_APB2011_01.pdf

Indiana University School of Public and Environmental Affairs. (2011). *Plug-in Electric Vehicles: A Practical Plan for Progress*. Retrieved from http://www.indiana.edu/~spea/pubs/TEP_combined.pdf

Ingram, A. (2011). Nissan e-NV200 Electric Van Concept : 2012 Detroit Auto Show. *Green Car Reports*. Retrieved from http://www.greencarreports.com/news/1071546_nissan-e-nv200-electric-van-concept-2012-detroit-auto-show

Intergovernmental Panel on Climate Change. (2007). *Climate Change 2007 Synthesis Report: An Assessment of the Intergovernmental Panel on Climate Change*. Retrieved from http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

International Energy Agency. (2008). *The electric drive gains momentum*. Retrieved from http://www.ieahev.org/pdfs/2007_annual_report.pdf

International Energy Agency. (2009). *The electric drive establishes a market foothold*. Retrieved from http://www.ieahev.org/pdfs/2008_annual_report.pdf

International Energy Agency. (2010). *CO2 emissions from fuel combustion 2010 - hilights*. Retrieved from http://www.iea.org/co2highlights/CO2highlights.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009a). *World Motor Vehicle Production by Country and Type 2008-2009 - Light Commercial Vehicles*. Retrieved from http://oica.net/wp-content/uploads/lcv-2008-2009-2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009b). *Vehicle Type Definitions*. International Organization of Motor Vehicle Manufacturers (OICA). Retrieved from http://oica.net/wp-content/uploads/stats-definition.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009c). *World Motor Vehicle Production by Country and Type 2008-2009 - Heavy Trucks*. Retrieved from http://oica.net/wp-content/uploads/trucks-2008-2009-2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009d). *World Ranking of Manufacturers Year 2009*. Retrieved from http://oica.net/wp-content/uploads/ranking-2009.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009e). *World Motor Vehicle Production by Country and Type 2008-2009 - All Vehicles*. Retrieved from http://oica.net/wp-content/uploads/all-vehicles-2008-2009_2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009f). *World Motor Vehicle Production by Country and Type 2008-2009 - Heavy Buses*. Retrieved from http://oica.net/wp-content/uploads/buses-2008-2009-2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2009g). *World Motor Vehicle Production by Country and Type 2008-2009 - Cars*. Retrieved from http://oica.net/wp-content/uploads/cars-2008-2009-2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2010a). *World Motor Vehicle Production by Country and Type 2009-2010 - Cars*. International Organization of Motor Vehicle Manufacturers (OICA). Retrieved from http://oica.net/wp-content/uploads/cars-2010-provisional.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2010b). *World Motor Vehicle Production by Country and Type 2009-2010 - Heavy Trucks*. Retrieved from http://oica.net/wp-content/uploads/hcv-2010-provisional.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2010c). *World Motor Vehicle Production by Country and Type 2009-2010 - Light Commercial Vehicles*. Retrieved from http://oica.net/wp-content/uploads/lcv-2010-provisional.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2010d). *World Motor Vehicle Production by Country and Type 2009-2010 - Heavy Buses*. Retrieved from http://oica.net/wp-content/uploads/buses-2008-2009-2.pdf

International Organization of Motor Vehicle Manufacturers (OICA). (2010e). *World Motor Vehicle Production by Country and Type 2009-2010 - All Vehicles* (Vol. 2010). Retrieved from http://oica.net/wp-content/uploads/all-vehicles-2010-provisional.pdf

Intuit Strategies. (2007). *Plug-In Hybrid Electric Vehicles: PHEV Technology in BC & Project Scoping*. Retrieved from http://www.veva.bc.ca/reports/phev_phase_1_report_final.pdf

J.D. Power and Associates. (2011). Global Automotive Outlook for 2011 Appears Positive as Mature Auto Markets Recover. J.D. Power and Associates. Retrieved from http://www.jdpower.com/news/pressRelease.aspx?ID=2011018

Jaeger, E. (2011). *Technology sourcing and exploitation in the knowledge economy : The case of the Hybrid Electric Vehicles industry*. Chalmers University of Technology. Retrieved from http://publications.lib.chalmers.se/records/fulltext/147035.pdf

Jeon, S. Y. (2010). *Hybrid & electric vehicle technology and its market feasibility*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/handle/1721.1/59252

Jesper Brauer. (2011). *When will hybrid technologies dominate the heavy-duty vehicle market ?* KTH Royal Institute of Technology, Sweden. Retrieved from http://kth.diva-portal.org/smash/record.jsf?pid=diva2:488793

Johnson, D. (2012). Why Ener1 Went Bankrupt. *IEEE Spectrum, Nanoclast Blog*. Retrieved from http://spectrum.ieee.org/nanoclast/semiconductors/nanotechnology/why-ener1-went-bankrupt

Jones, W. D. (2005). Take this car and plug it. *IEEE Spectrum*, *42*(7), 6. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Take+This+Car+And+PLUG+IT#0

Jorgensen, K. (2008). Technologies for electric, hybrid and hydrogen vehicles: Electricity from renewable energy sources in transport. *Utilities Policy*, *16*(2), 72–79. doi:10.1016/j.jup.2007.11.005

Kalhammer, F.R., Kamath, H., Duvall, M., Alexander, M., & Jungers, B. (2009). Plug-In Hybrid Electric Vehicles: Promise, Issues and Prospects. *EVS24 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium. Stavanger, Norway*, 1–11. Retrieved from http://www.cars21.com/files/papers/Kalhammer.pdf

Kalhammer, Fritz R., Kopf, B. M., Swan, D. H., Roan, V. P., & Walsh, M. P. (2007). *Status and Prospects for Zero Emissions Vehicle Technology Report of the ARB Independent Expert Panel 2007*. *Cell*. Retrieved from www.arb.ca.gov/msprog/zevprog/zevreview/zev_panel_report.pdf

Kang, H. (2007). *An analysis of hybrid-electric vehicles as the car of the future*. Massachusetts Institute of Technology. Retrieved from http://mit.dspace.org/bitstream/handle/1721.1/40442/191701876.pdf?sequence=1

Kansas City Business Journal. (2012, March 6). Smith Electric Vehicles starts making new step van. *Kansas City Business Journal*. Retrieved from http://www.bizjournals.com/kansascity/news/2012/03/06/smith-electric-vehicles-starts-making.html

Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review*, *74*(1). Retrieved from http://www.mtsu.edu/~jclark/698/articles/698-UsingtheBalancedScorecard.pdf

Kar, S. (2010). *North American and European Hybrid and Electric Commercial Vehicle Markets - Indications and Opportunities of Growth for Azure Dynamics*.

Kar, S., & Devadoss, R. (2010). *EU and NA Hybrid Buses , Vans and Trucks Market- Market Pull Dictating Growth Trajectory*. Frost & Sullivan. Retrieved from http://www.frost.com/prod/servlet/analyst-briefing-detail.pag?mode=open&sid=198317641

Kar, S., & Randall, J. M. (2010). *Strategic Analysis of the North American and European Electric Commercial Vehicle Market*. Retrieved from http://www.frost.com/prod/servlet/report-toc.pag?repid=M4DE-01-00-00-00

Karden, E., Ploumen, S., Fricke, B., Miller, T., & Snyder, K. (2007). Energy storage devices for future hybrid electric vehicles. *Journal of Power Sources*, *168*(1), 2–11. doi:10.1016/j.jpowsour.2006.10.090

Kargul, J. J. (2007). Hydraulic Hybrid Vehicles 101 - Delivering Efficiency to Commercial Vehicles. *South Coast AQMD Hydraulic Hybrid Forum, November 15, 2007*. South Coast Air Quality Management District (AQMD). Retrieved from http://www.aqmd.gov/tao/conferencesworkshops/HydraulicHybridForum/KargulSlidesFirst.pdf

Karplus, V. J. V. J., Paltsev, S., & Reilly, J. M. J. M. (2010, October). *Prospects for plug-in hybrid electric vehicles in the United States and Japan: A general equilibrium analysis*. *Transportation Research Part A: Policy and Practice*. Elsevier. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0965856410000728

Kassatly, S. S. N. (2010). The lithium-ion battery industry for electric vehicles. Retrieved from http://dspace.mit.edu/handle/1721.1/61873

Katrašnik, T. (2009). Analytical framework for analyzing the energy conversion efficiency of different hybrid electric vehicle topologies. *Energy Conversion and Management*, *50*(8), 1924–1938. doi:10.1016/j.enconman.2009.04.016

Kazozcu, S. B. (2011). Role of strategic flexibility in the choice of turnaround strategies: A resource based approach. *Procedia - Social and Behavioral Sciences*, *24*, 444–459. doi:10.1016/j.sbspro.2011.09.039

Keating, M. (2009). Hybrid bus line passes test, now eligible for federal funds. Azure Dynamics Corporation. Retrieved from http://www.azuredynamics.com/about-azd/documents/Hybridbuslinepassestest.pdf

Keating, M. (2011). Fleets: Electric vehicle producer sees opportunity in Obama fleet directive. *govpro.com*. Penton Media, Inc. Retrieved from http://govpro.com/fleets/content/Fleets-Azure-20110901/

Keenan, G. (2011). Magna , Ontario to invest $400-million in R & D for electric vehicles. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/report-on-business/magna-ontario-to-invest-400-million-in-rd-for-electric-vehicles/article2144964/

Kelly, L., Williams, T., Kerrigan, B., & Crawford, C. (2009). *Electrifying the BC Vehicle Fleet: Opportunities and Challenges for Plug-in Hybrid, Extended Range & Pure Electric Vehicles*. Pacific Institute for Climate Solutions, University of Victoria. Retrieved from http://www.pics.uvic.ca/assets/pdf/publications/Electrifying the BC Vehicle Fleet.pdf

Kendall, G. (2008). Plugged in: the end of the oil age. *WWF (World Wide Fund for Nature)*, (March 2008). Retrieved from http://www.emc-mec.ca/files/Kendall_SustAinability.pdf

Khusid, M. (2010). *Potential of Electric Propulsion Systems to Reduce Petroleum Use and Greenhouse Gas Emissions in the US Light-Duty Vehicle Fleet*. Massachusetts Institute of Technology. Retrieved from http://web.mit.edu/sloan-auto-lab/research/beforeh2/files/Khusid_Thesis_May_20_2010.pdf

Kilcarr, S. (2010). Duty cycle critical to hybrid truck decision. *FleetOwner*. Bobit Business Media. Retrieved from http://fleetowner.com/management/news/duty-cycle-critical-hybrid-truck-decision-1022/

King, D. (2011). Ford Won't Include Battery Leasing Option for Upcoming EVs. *Green Car Advisor*. Edmunds.com. Retrieved April 13, 2011, from http://blogs.edmunds.com/greencaradvisor/2011/03/ford-wont-include-battery-leasing-option-for-upcoming-evs.html

Klayman, B. B. (2012). Electric car revolution faces increasing headwinds. *Reuters.com*, pp. 8–10. Retrieved from http://www.reuters.com/article/2012/03/21/electriccars-idUSL1E8EJ7F320120321

Kong, H. (1999). Creating the Japanese electric vehicle industry : the challenges of uncertainty and cooperation, *31*, 997–1016.

Koprowicz, G. (2011). Important technology for hybrid market Azure Dynamics at 2011 NAIAS Show. *Gadgets Examiner*. Retrieved from http://www.examiner.com/gadgets-in-ann-arbor/important-technology-for-hybrid-market-azure-dynamics-at-2011-naias-show

Kosub, J. (2010). *Transitioning to a Greener Fleet : A Cost-Benefit Analysis of a Vehicle Fleet Program at the Texas General Land Office in Austin , Texas*. Texas State University. Retrieved from http://ecommons.txstate.edu/arp/329/

Kotler, P., Adam, S., Brown, L., & Armstrong, G. (2001). *Principles of Marketing*. Pearson Education Australia.

Kramer, M. R., & Porter, M. E. (2006). Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review*, (December 2006), 78–92. Retrieved from http://www.hks.harvard.edu/m-rcbg/CSRI/events/2006.10.10_Mark Kramer_Presentation.pdf

Kromer, M. A. (2007). *Electric powertrains: opportunities and challenges in the US light-duty vehicle fleet*. Massachusetts Institute of Technology. Retrieved from http://dspace.mit.edu/handle/1721.1/40372

Kromer, M. A., Bandivadekar, A., & Evans, C. (2010). Long-term greenhouse gas emission and petroleum reduction goals: Evolutionary pathways for the light-duty vehicle sector. *Energy*, *35*(1), 387–397. doi:10.1016/j.energy.2009.10.006

Krupnick, A. (2010). *Energy, Greenhouse Gas, and Economic Implications of Natural Gas Trucks*.

Krupnick, A. J. (2011). *Will Natural Gas Vehicles Be in Our Future? Energy Economics*. Resources for the Future, Center for Energy Economics and Policy. Retrieved from http://www.rff.org/RFF/Documents/RFF-IB-11-06.pdf

Krutilla, K., & Graham, J. D. (2012). Are Green Vehicles Worth the Extra Cost ? The Case of Diesel-Electric Hybrid Technology for Urban Delivery Vehicles, *31*(3), 501–532. doi:10.1002/pam

Kurani, K. S., & Turrentine, T. S. (2007). Interpersonal Influence within Car Buyers ' Social Networks : Observing Consumer Assessment of Plug-in Hybrid Electric Vehicles (PHEVs) and the Spread of Pro-Societal Values By JONN AXSEN Submitted in partial satisfaction of the requirements for the deg.

Lache, R., Mulally, A., & Kuzak, D. (2011). *Ford Investor Presentation - 2011 North American International Auto Show*. Retrieved from http://corporate.ford.com/doc/ir_20110111_naias_conference.pdf

Lache, R., Nolan, P., & Chang, S. (2009). *Electric Cars: Plugged In 2 - A mega-theme gains momentum*. Retrieved from http://www.fullermoney.com/content/2009-11-03/ElectricCarsPluggedIn2.pdf

Lache, R., Nolan, P., & Crane, J. (2008). *Electric Cars : Plugged In Batteries must be included*. Retrieved from http://www.inrets.fr/fileadmin/recherche/transversal/pfi/PFI_VE/pdf/deutch_bank_electric_cars.pdf

Lammert, M. (2009). *Twelve-Month Evaluation of UPS Diesel Hybrid Electric Delivery Vans*.

Lauber, D. (2009). Electric Vehicles 101. Retrieved from http://web.mit.edu/evt/EVs 101 - 11-13-09(web).ppt

Lazzarotti, V., & Pizzurno, E. (2010). What is the place of technical and scientific service companies (TSS) in the process of developing new products ? Insights on their managerial and organizational features, *2*(9), 39–53.

Leonnig, C. D. (2012). Start-up Bright Automotive will close its doors.pdf. *Washington Post*.

Li, J. (2010). Prospect of China Automotive Industry in 2020. *FISITA 2010 WORLD AUTOMOTIVE CONGRESS*. FISITA - International Federation of Automotive Engineering Societies. Retrieved from http://www.diamond-congress.hu/fisita2010/plenaries/pdf/li.pdf

Li, Z., & Sun, L. (2011). *The impact of the government policy on the Chinese electric vehicle industry and business strategy management: Case of FAW*. Linkopings University. Retrieved from http://www.iei.liu.se/program/smio/722a31/file-archive/1.273563/LiZhe_SunLu-TheimpactofthegovernmentpolicyontheChineseelectricvehicleindustryandbusinessstrategymanagement.pdf

Liang, F.-Y., Ryvak, M., Sayeed, S., & Zhao, N. (2012). The role of natural gas as a primary fuel in the near future, including comparisons of acquisition, transmission and waste handling costs of as with competitive alternatives. *Chemistry Central Journal*, *6*(Suppl 1), S4. doi:10.1186/1752-153X-6-S1-S4

Lienert, A. (2011). Electric Renault Kangoo Maxi ZE Revealed : 2011 Geneva Auto Show. *InsideLine*. Edmunds, Inc. Retrieved February 26, 2011, from http://www.insideline.com/renault/electric-renault-kangoo-maxi-ze-revealed-2011-geneva-auto-show.html

Lipman, T., & Delucchi, M. (2006). A retail and lifecycle cost analysis of hybrid electric vehicles. *Transportation Research Part D: Transport and Environment*, *11*(2), 115–132. doi:10.1016/j.trd.2005.10.002

Lloyd, M., & Blows, J. (2009). *Who holds the power? Lessons from hybrid car innovation for clean technologies*. Retrieved from http://www.google.com/url?sa=t&source=web&cd=4&ved=0CCIQFjAD&url=http%3A%2F%2Fwww.griffithhack.com.au%2Fmediacentre-LessonsfromHybridCarInnovationforCleanTechnologies&ei=oexATeagK4KB8gbGyNyLBA&usg=AFQjCNGK7hISLc8nmZQInPqtvcLxLxPOBg&sig2=twGfXKIbIs8q2ys-GRw6bA

Lowe, M., Ayee, G., & Gereffi, G. (2009). *Hybrid Drivetrains for Medium- and Heavy-Duty Trucks*. Retrieved from http://www.cggc.duke.edu/environment/climatesolutions/greeneconomy_Ch9_HybridDrivetrainsforTrucks.pdf

Lowe, M., Tokuoka, S., Trigg, T., & Gereffi, G. (2010a). *Case Study : A123 Systems Local Markets and Competitiveness A Value Chain Analysis*. Center on Globalization, Governance & Competitiveness (CGGC), Duke University. Retrieved from http://www.cggc.duke.edu/pdfs/CGGC_A123_CaseStudy_10-22-10.pdf

Lowe, M., Tokuoka, S., Trigg, T., & Gereffi, G. (2010b). *Lithium-ion batteries for Hybrid and All-Electric vehicles: the U.S. Value Chain*. Center on Globalization, Governance & Competitiveness (CGGC), Duke University. Retrieved from http://www.cggc.duke.edu/pdfs/Lithium-Ion_Batteries_10-5-10.pdf

MIT Energy Initiative Symposium. (2010). Electrification of the Transportation System. *Electrification of the Transportation System, An MIT Energy Initiative Symposium*. Massachusetts Institute of Technology. Retrieved from http://web.mit.edu/mitei/docs/reports/electrification-transportation-system.pdf

Madian, A. L., Walsh, L. A., Simpkins, K. D., & Gordon, R. S. (2008). *U.S. Plug-In Hybrid and U.S. Light Vehicle Data Book*. Retrieved from http://www.cleanenergycouncil.org/files/plugin_hybrid_databook.pdf

Magnusson, T., & Berggren, C. (2011). Entering an era of ferment - radical vs incrementalist strategies in automotive power train development. *Technology Analysis & Strategic Management*, *23*(3), 313–330. doi:10.1080/09537325.2011.550398

Mallia, E. (2012). How to Responsibly Green Your Fleet. FleetCarma. Retrieved from http://www.fleetcarma.com/en/Resources/how-to-responsibly-green-your-fleet-ebook

Mangram, M. E. (2012). The globalization of Tesla Motors : a strategic marketing plan analysis. *Journal of Strategic Marketing*, *20*(4), 289–312. doi:10.1080/0965254X.2012.657224

Mantravadi, P., Husain, I., & Sozer, Y. (2011). Modeling, implementation and analysis of a Li-ion battery powered electric truck. *Energy Conversion Congress and Exposition (ECCE), 2011 IEEE* (pp. 1428–1435). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6063948

Mantravadi, S. R. P. (2011). *Modeling, Simulation & Implementation of Li-ion Battery Powered Electric and Plug-in Hybrid Vehicles*. The University of Akron. Retrieved from http://etd.ohiolink.edu/send-pdf.cgi/Mantravadi Siva Rama Prasanna.pdf?akron1310756846&dl=y

Markel, A. J., & Simpson, A. (2006). Plug-in hybrid electric vehicle energy storage system design. *Advanced Automotive Battery Conference*. National Renewable Energy Laboratory. Retrieved from http://www.spinnovation.com/sn/Batteries/Plug-in_Hybrid_Electric_Vehicle_Energy_Storage_System_Design_Conference_Paper.pdf

Markel, T., & Simpson, A. (2006a). Cost-benefit analysis of plug-in hybrid electric vehicle technology. *WEVA Journal*, *1*. Retrieved from http://ecoseed.org/whitePapers/Green-Tranportation-BEV_Cost-Benefit-Analysis-of-Plug-In-Hybrid-Electric-Vehicle-Technology.pdf

Marketline.com. (2011d). *Company Profile: Renault SA* (pp. 1–35).

Marketline.com. (2011e). *Company Profile: Enova Systems, Inc.* (pp. 1–16). Retrieved from http://www.datamonitor.com/store/Product/enova_systems_inc?productid=0336FF26-763E-4FCE-AD32-21D2A4A00410

Marketline.com. (2011f). *Company Profile: Continental AG*.

Marketline.com. (2011h). *Company Profile: Eaton Corporation*. Retrieved from http://www.datamonitor.com/store/Product/eaton_corporation?productid=335FEC65-B678-4881-A234-E71F8A687920

Marketline.com. (2011i). *Company Profile: Magna International, Inc.*

Marketline.com. (2011k). *Company profile: Spartan Motors, Inc.* (pp. 1–18).

Marketline.com. (2011l). *Company Profile: PACCAR Inc.*

Marketline.com. (2012a). *Company Profile: Navistar International*.

Marketline.com. (2012b). *Company Profile: Daimler AG.*

Marketline.com. (2012c). *Company Profile: Johnson Controls, Inc.* (pp. 1–33).

Marketline.com. (2012d). *Company Profile: Isuzu Motors Limited* (pp. 1–22).

Marketline.com. (2012e). *Company Profile: Nissan Motor Co., Ltd.*

Matheys, J. (2005). *SUBAT: SUSTAINABLE BATTERIES Work package 5: Overall Assessment Final Public Report*. Vrije Universiteit Brussel. Retrieved from http://134.184.33.110/battery/subatdocs/WP5-006.pdf

Mathworks Corporation. (2009). Azure Dynamics Achieves 80% Code Reuse Across Powertrain Control Projects. Mathworks Corporation. Retrieved from http://www.mathworks.com/control-systems/userstories.html?file=45580 3/19/2011

Mathyssek, R. (2009). Global Truck Markets: Structural Shifts or Cyclicality Taken to the Extreme? *Global Automotive Conference 2009, Munich*. IHS Global Insight. Retrieved from http://www.ihsglobalinsight.com/gcpath/Munich_Roman_Mathyssek.pdf

Mattucci, A., Rieder, S., Månsson, T., & Kargk, M. (2001). Deployment Strategies For Hybrid , Electric And Alternative Fuel Vehicles. Retrieved from http://www.iea.org/impagr/cip/hybrid.pdf

McKinsey and Company. (2010). *A portfolio of powertrains for Europe : a fact-based analysis*. Retrieved from http://www.iphe.net/docs/Resources/Power_trains_for_Europe.pdf

McKinsey and Company. (2011). *Boost! - Transforming the powertrain value chain - a portfolio challenge*. Retrieved from http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cts=1331702804800&ved=0CCUQFjAA&url=http%3A%2F%2Fwww.inrets.fr%2Ffileadmin%2Frecherche%2Ftransversal%2Fpfi%2FPFI_VE%2Fpdf%2FMcKinsey_boost.pdf&ei=uipgT6SVGoGxiwLHtsGNDQ&usg=AFQjCNEnCf6RHiwlbPXRb8dfCifz31hfHQ&sig2=QElj3SKqj-S2-jjy9cPOSw

Mcmahon, D. (2008). *The Low Speed electric Vehicle (LSV): A Made-in-Canada Solution , Not Welcome in Canada*. *Federal Register*. Retrieved from http://www.econogics.com/TENHE/The LSV - Made in Canada Solution.doc

Mcmanus, W., & Senter, R. (2009). *Market Models for Predicting PHEV Adoption and Diffusion*. Retrieved from http://deepblue.lib.umich.edu/bitstream/2027.42/64436/1/102399.pdf

Mellander, J., & Svanberg, J. (2008). *Value Drivers of the Automotive Industry*. *Industrial Engineering*. Stockholm. Retrieved from http://www.kth.se/polopoly_fs/1.174994!/Menu/general/column-content/attachment/2008_81.pdf

Menzies, J. (2012). When greening your fleet, focus on existing vehicles first : FedEx exec. *TruckNews.com*. Retrieved from http://www.trucknews.com/news/when-greening-your-fleet-focus-on-existing-vehicles-first-fedex-exec/1000986449/

Meyer, G. (2007). The Light Commercial Vehicle Surge in Europe – When Will the Tide Break ? *Global Automotive Conference 2007, Munich*. IHS Global Insight. Retrieved from http://www.ihsglobalinsight.com/gcpath/Munich_Roman_Mathyssek.pdf

Michigan Policy Network. (2011). Electric Car Incentive Expansion Proposed. *Michigan Policy Network*. Retrieved from http://www.michiganpolicy.com/index.php?option=com_content&view=article&id=1029:electric-car-incentive-expansion-proposed&catid=39:energy-and-environment-policy-briefs&Itemid=138

Mikkola, J. (2001). Portfolio management of R&D projects: implications for innovation management. *Technovation*, *21*(7), 423–435. doi:10.1016/S0166-4972(00)00062-6

Milford, P., & McCarty, D. (2012). Ener1 , Parent of U.S. Subsidized Battery Unit, Seeks Bankruptcy. *Bloomberg.com*.

Miller, J. (2010). *The Economic Impact of Emissions Caps on Plug-in Hybrid Electric Vehicles*. The Ohio State University. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:The+Economic+Impact+of+Emissions+Caps+on+Plug-in+Hybrid+Electric+Vehicles#0

Miller, J. M. (2005). Hybrid Electric Vehicles. In A. Emadi (Ed.), *Handbook of Automotive Power Electronics and Motor Drives2*. CRC Press, Taylor and Francis Group LLC.

Miller, S. (2007). Engine Manufacturer Perspective (on HHVs). *AQMD Hydraulic Hybrid Vehicle Forum*. South Coast Air Quality Management District (AQMD). Retrieved from http://www.aqmd.gov/tao/ConferencesWorkshops/HydraulicHybridForum/MillerSlides.pdf

Millner, A., Judson, N., Ren, B., Johnson, E., & Ross, W. (2010). Enhanced plug-in hybrid electric vehicles. *Innovative Technologies for an Efficient and Reliable Electricity Supply (CITRES), 2010 IEEE Conference on* (pp. 333–340). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5619783

Mims, C. (2009). Hybrid Trucks Are Here for the Long (Medium and Short) Haul. *Scientific American*, (April 20, 2009). Retrieved from http://www.scientificamerican.com/article.cfm?id=hybrid-trucks

Mock, P., Hülsebusch, D., Ungethüm, J., & Schmid, S. A. (2009). Electric vehicles–A model based assessment of future market prospects and environmental impacts, 1–14. Retrieved from http://www.cars21.com/files/papers/Mock-paper.pdf

Mock, P., & Schmid, S. A. (2009). *Market prospects of electric passenger vehicles and their effect on CO2 emissions up to the year 2030–A model based approach* (pp. 1–10). Retrieved from http://elib.dlr.de/60451/1/090723_PHEV09_DLR.pdf

Molnár, E. (2009). *Strategic Management In The Ailing Automobile Industry*. Retrieved from http://elib.kkf.hu/edip/D_14581.pdf

Moore, B. (2010). Enough with the “Not Invented Here”. *EVWORLD.COM*. Retrieved from http://www.evworld.com/syndicated/evworld_article_1532.cfm

Moore, J. W. (2009). *MONTREAL 2009 PHEV CONFERENCE*. Retrieved from http://evworld.com/pdf/montreal2009phev.pdf

Moore, L. (2011). Electric vehicle impact “impossible” to predict. *Montreal Gazette*. Retrieved from http://www.montrealgazette.com/cars/Electric+vehicle+impact+impossible+predict/5467168/story.html

Morrow, K., Karner, D., & Francfort, J. (2008). *Plug-in hybrid electric vehicle charging infrastructure review*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://avt.inl.gov/pdf/phev/phevInfrastructureReport08.pdf

Motavalli, B. Y. J. I. M. (2012). For the Electric Car, A Slow Road to Success. *Yale Environment 360*. Retrieved from http://e360.yale.edu/content/print.msp?id=2488

Motavalli, J. (2011). UPS Likes Its Clean Trucks Just Fine, but Says Brown Can’t Afford More Green. *BNET Plugged In Blog*. CBS Interactive Business Network. Retrieved from http://www.bnet.com/blog/electric-cars/ups-likes-its-clean-trucks-just-fine-but-says-brown-can-8217t-afford-more-green/3390

Motavalli, J. (2012, February 17). 2013 Budget Would Increase Alternative-Powertrain Tax Credit to $10,000. *The New York Times*. Retrieved from http://wheels.blogs.nytimes.com/2012/02/17/2013-budget-would-increase-alternative-powertrain-tax-credit-to-10000/

Mukhopadhyay, B. (2012). Azure Dynamics shares fall on 2011 revenue forecast cut. Reuters.com. Retrieved from http://ca.reuters.com/articlePrint?articleId=CATRE77B3PL20110812 8/21/2011

Muller, J. (2012, March 1). Is America Blowing Its Chance To Lead In Electric Vehicles ? *Forbes*. Retrieved from http://www.forbes.com/sites/joannmuller/2012/03/01/is-america-blowing-its-chance-to-lead-in-electric-vehicles/

Muster, T. (2000). *Fuel Savings Potential and Costs Considerations for US Class 8 Heavy Duty Trucks through Resistance Reductions and improved Propulsion Technologies until 2020*. Retrieved from http://javlonworks.narod.ru/other/virlib/_Education/_article/Auto_trans/el00-001_1.pdf

NHTSA. (2010). *Medium- and Heavy-Duty Fuel Efficiency Improvement Program - Draft Environmental Impact Statement*. National Highway Transportation Safety Association (NHTSA). Retrieved from http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/02_DEIS_102010t.pdf

National Research Council - Board on Energy and Environmental Systems. (2010). *Transitions to Alternative Transportation Technologies - Plug-In Hybrid Electric Vehicles*. Retrieved from http://www.nap.edu/openbook.php?record_id=12826&page=21

National Research Council - Board on Energy and Environmental Systems. (2011). *Review of the 21st Century Truck Partnership, Second Report*. *Review Literature And Arts Of The Americas*. National Research Council, National Academies Press. Retrieved from http://www.google.ca/url?q=http://www.nap.edu/catalog/13288.html&sa=U&ei=a6DMToLbBoH-iQKz8tGKDA&ved=0CBoQFjAA&sig2=y9wDE0LOk4txr6_zh-PA2w&usg=AFQjCNH_3sKd4ckLhQ9xaESHLNosaaa-oQ

National Research Council - Transportation Research Board. (2010). *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles*. National Research Council - Transportation Research Board. Retrieved from http://www.nap.edu/catalog.php?record_id=12845

Natural Gas Vehicles for America. (2009). *Natural Gas Vehicle Incentive Program*. Retrieved from http://www.google.ca/url?q=http://cleanenergysolutions.org/node/723&sa=U&ei=I7RRTrOQIsnSiAKzkZCYAQ&ved=0CBMQFjAA&sig2=naCfMpsFOLPWhEpT2KhU4Q&usg=AFQjCNFaYn-bSix9UejvR_GKCn9w3a_jOQ

Natural Resources Canada. (2007). *Canadian Vehicle Survey Summary Report 2005*. Natural Resources Canada. Retrieved from http://oee.nrcan.gc.ca/publications/statistics/cvs07/pdf/cvs07.pdf

Natural Resources Canada. (2009). *Canadian Vehicle Survey Summary Report 2007*. Natural Resources Canada.

Natural Resources Canada. (2010). *Canadian Vehicle Survey - Update Report 2008*.

Natural Resources Canada Office of Energy Efficiency. (2008). *Energy Efficiency Trends in Canada 1990 to 2005*. Retrieved from http://oee.nrcan.gc.ca/publications/statistics/trends07/index.cfm?attr=0

Nemry, F., Leduc, G., & Munoz, A. (2009). *Plug-in Hybrid and Battery-Electric Vehicles: State of the research and development and comparative analysis of energy and cost efficiency*. *JRC*

Technical Notes. European Commission, Joint Research Centre, Institute for Prospective Technological Studies. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Plug-in+Hybrid+and+Battery-Electric+Vehicles+:+State+of+the+research+and+development+and+comparative+analysis+of+energy+and+cost+efficiency#0

Nesbitt, K., & Sperling, D. (2001). Fleet purchase behavior: decision processes and implications for new vehicle technologies and fuels. *Transportation Research Part C: Emerging Technologies*, *9*(5), 297–318. Retrieved from http://www.sciencedirect.com/science/article/pii/S0968090X00000358

New Car Dealers of BC. (2011). CEV for BC - Clean Energy Vehicles for British Columbia. New Car Dealers of BC. Retrieved from http://www.cevforbc.ca

News, L., Portrait, D. S., & Tips, T. (2012). Lackluster electric car sales imperil Michigan's battery firms. *Development*, 1–6.

NextEnergy. (2010a). *Hydraulic Hybrid Vehicles*. NextEnergy News. Retrieved from http://www.nextenergy.org/Modules/Document/upload_documents/NEC-HHV-Q&ABrochure.pdf

NextEnergy. (2010b). Hydraulic Hybrid Working Group. Retrieved from http://www.nextenergy.org/services/strategic/workinggroups/wg_hydraulichybrid.aspx

NextEnergy. (2010c). *Hydraulic Hybrid Vehicles* (pp. 1–2). NextEnergy News. Retrieved from http://www.nextenergy.org/services/strategic/workinggroups/wg_hydraulichybrid.aspx

Nilsson, P. M., & Schreiber, D. (2009). *Powertrain at the Crossroads; Mapping the Future for the Global Bus and Truck Industry*. Retrieved from http://www.adlittle.com/downloads/tx_adlreports/ADL_Powertrain.pdf

Nissan Corporation. (2008). NISSAN HANOVER MOTOR SHOW 2008. Nissan Corporation. Retrieved from http://www.newsroom.nissan-europe.com/download/media/specialfile/1926_1_5.aspx/1926

Nordstrom, K., & De Los Rios, A. (2011). *Analyzing the Vehicle-to-Grid (V2G) Potential for Electric and Plug-In Hybrid Fleets*.

Notter, D. A., Gauch, M., Widmer, R., Wäger, P., Stamp, A., Zah, R., & Althaus, H.-J. (2010). Contribution of Li-ion batteries to the environmental impact of electric vehicles. *Environmental science & technology*, *44*(17), 6550–6. doi:10.1021/es903729a

Odendahl, M. (2012). Navistar turns to natural gas. *etruth.com*. Retrieved from http://www.etruth.com/article/20120206/BUSINESS/702069991%26source%3DRSS

Ornelas, E. (2007). PG&E's View: PHEVs , V2G and the Progress so far. *Plug-in Highway Network PHEV2007 Conference*. Retrieved from http://umanitoba.ca/outreach/conferences/phev2007/PHEV2007/proceedings/PluginHwy_PHEV2007_Session5_Ornelas.pdf

PRTM Inc. (2010). Paving the Way for Electric Vehicles. PRTM Inc. Retrieved from http://www.prtm.com/uploadedFiles/Thought_Leadership/Perspectives/PRTM_Paving_the_Way_for_Electric_Vehicles.pdf

Parish, R. (2010). Medium and Heavy-Duty Hybrid Trucks for Municipal Operations. *Federation of Canadian Municipalities 2010*. CALSTART.

Parnell, J. A. (2009). Industry Competition. *Strategic Management: Theory and Practice, 3rd Edition* (pp. 37–60). Atomic Dog Publishing.

Perry, M. (2012). Unplug Electric Car Subsidies. *Detroit News*. Retrieved from http://www.detroitnews.com/article/20120119/OPINION01/201190339

Pesaran, A. (2007). Battery choices and potential requirements for plug-in hybrids. *Plug-in Hybrid Electric Truck Workshop, Hybrid Truck Users Forum, Los Angeles, CA*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/41328.pdf

Pesaran, A. A., Markel, T., Tataria, H. S., & Howell, D. (2007). Battery Requirements for Plug-In Hybrid Electric Vehicles – Analysis and Rationale. *23rd International Electric Vehicles Symposium and Exposition (EVS 23), Sustainability: The Future of Transportation*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/42240.pdf

Pesaran, A., & Markel, T. (2007). Battery Requirements and Cost-Benefit Analysis for Plug-In Hybrid Vehicles (Presentation). *24th International Battery Seminar, Fort Lauderdale, Florida*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/42082.pdf

Pike Research. (2011). Hybrid Medium and Heavy Duty Trucks. Pike Research. Retrieved from http://www.pikeresearch.com/research/hybrid-medium-and-heavy-duty-trucks

Pike Research. (2012a). New Coalition Brings Together Industry Leaders To Design National Model For Electric Vehicle Deployment. PR Newswire. Retrieved from http://www.prnewswire.com/news-releases/new-coalition-brings-together-industry-leaders-to-design-national-model-for-electric-vehicle-deployment-136824103.html

Pike Research. (2012b). Consumer Interest in Plug-in Electric Vehicles Declines to 40 %, According to Pike Research. *Business Wire*. Berkshire Hathaway Company. Retrieved from http://www.pikeresearch.com/newsroom/consumer-interest-in-plug-in-electric-vehicles-declines-to-40

Pike Research. (2012c). Sales of Hybrid Medium and Heavy Duty Trucks Will Nearly Double in 2012. *Business Wire*. Berkshire Hathaway. Retrieved from http://www.businesswire.com/news/home/20120112005412/en/Sales-Hybrid-Medium-Heavy-Duty-Trucks-Double

Plotkin, S., & Singh, M. (2009a). *Multi-Path Transportation Futures Study : Vehicle Characterization and Scenario Analyses, Main Text and Appendices A, B, C, D, and F*. Argonne National Laboratory, Energy Systems Division. Retrieved from http://www.transportation.anl.gov/pdfs/TA/613.PDF

Plotkin, S., & Singh, M. (2009b). *Multi-Path Transportation Futures Study : Vehicle Characterization and Scenario Analyses, Appendix E: Other NEMS-MP Results for the Base Case and Scenarios*. Argonne National Laboratory, Energy Systems Division. Retrieved from http://www.transportation.anl.gov/pdfs/TA/614.PDF

Pohl, H., & Elmquist, M. (2008). On the way to electric cars - a case study of a hybrid electric vehicle project at Volvo Cars. *R&D Management Conference, Ottawa, Canada, June 17-20, 2008*. Chalmers University of Technology. Retrieved from http://www.r2ds-ile-de-france.com/IMG/pdf/Pohl_and_Elmquist_2008_R_D_Mgmt.pdf

Pohl, H., & Elmquist, M. (2010). Radical innovation in a small firm: a hybrid electric vehicle development project at Volvo Cars. *R&D Management*, *40*(4), 372–382. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9310.2010.00608.x/full

Polk LLP - Commercial Vehicle Solutions. (2009). *Commercial Vehicle Market Intelligence Report December 2009* (Vol. 203). doi:10.1093/infdis/jir001

Polk LLP - Commercial Vehicle Solutions. (2011). *Quarterly Commercial Vehicle Report, March 2011*. Retrieved from https://www.polk.com/knowledge/download/march_2011_quarterly_commercial_vehicle_report

Pollution Probe. (2010). *Primer on Automobile Fuel Efficiency and Emissions*. Retrieved from http://www.caa.ca/primer/

Porter, M. E. (1996). What Is Strategy? *Harvard Business Review*, *74*(6), 61–78. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:What+is+Strategy+?#0

Porter, M. E. (1998a). *Competitive Advantage: Creating and sustaining superior performance*. The Free Press, A Division of Simon & Schuster Inc.

Porter, M. E. (1998b). *Competitive Strategy: Techniques for Analyzing Industries and Competitors* (2nd Ed.). The Free Press, A Division of Simon & Schuster Inc. Retrieved from http://books.google.ca/books?id=QN0kyeHXtJMC

Porter, M. E. (1998c). Clusters And The New Economics Of Competition. *Harvard Business Review*, *76*(6), 77–90. Retrieved from http://proxy.lib.sfu.ca/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=1246493&site=bsi-live

Porter, M. E. (2008). The Five Competitive Forces That Shape Strategy. *Harvard Business Review*, *86*(January), 78–94. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18271320

Porter, M. E., & Kramer, M. R. (2011). Creating Shared Value. *Harvard Business Review*, (February).

Pretorius, M. (2008). When Porter’s generic strategies are not enough: complementary strategies for turnaround situations. *Journal of Business Strategy*, *29*(6), 19–28. doi:10.1108/02756660810917200

PriceWaterhouseCoopers LLP. (2010). *Estimate Of Fair Market Value Of Magna E-Car As At March 31, 2010*. Retrieved from http://www.magna.com/magna/_pdf/PwC_valuation_report.pdf

Province of BC Ministry of Environment. (2011). New rebates help BC drivers plug into clean cars. Province of BC, Ministry of Environment. Retrieved from http://www2.news.gov.bc.ca/news_releases_2009-2013/2011ENV0060-001428.htm 11/28/2011

Province of BC Ministry of Environment - Live Smart BC. (2011). Examples of Clean Energy Vehicles and Incentive Levels - CEV For BC Program. Province of BC, Ministry of

Environment. Retrieved from http://www.livesmartbc.ca/incentives/transportation/vehicle_incentives_list.pdf

Ramsey, M. (2011). Azure Sees Energy Plan Spurring Hybrid Vehicles. *MarketWatch*. Marketwatch.com. Retrieved April 13, 2011, from http://www.marketwatch.com/story/azure-calls-energy-plan-boon-to-hybrid-vehicle-sales-2011-03-30

Ramsey, M. (2012, March 27). Maker of Electric Vans Shuts. *Wall Street Journal*, pp. 1–2. Retrieved from http://online.wsj.com/article/SB10001424052702303816504577307672196301122.html

Raspin, P., & Terjesen, S. (2007). Strategy making: what have we learned about forecasting the future? *Business Strategy Series*, *8*(2), 116–121. doi:10.1108/17515630710685177

Raymond James Ltd. (2010). *Best Picks 2010* (pp. 7–8). Retrieved from https://www.raymondjames.ca/cda/display.do?contentid=7de43dfbd34cb210VgnVCMServeraf0c0caaSTFL

Renault Group. (2011a). Hertz and Renault partner to bring electric vehicles to European rental markets. Renault Group. Retrieved from http://www.media.renault.com/global/en-gb/renaultgroup/media/pressrelease.aspx?mediaid=27882

Renault Group. (2011b). Renault Atlas March 2011. Retrieved from www.renault.ua/upload/file/Company/atlas.pdf

Rishi, S., Gyimesi, K., Burek, C., & Monday, M. (2009). *Truck 2020 - Transcending turbulence*. IBM Global Business Services. Retrieved from https://www-935.ibm.com/services/us/gbs/bus/html/future-of-truck-industry-2020.html

Rishi, S., Stanley, B., & Gyimesi, K. (2008). *Automotive 2020 - Clarity beyond the chaos*. Retrieved from http://www-07.ibm.com/shared_downloads/6/IBM_Automotive_2020_Study_Clarity_beyond_the_Chaos.pdf

Ritchie, W. (2010). Why Aren't All UPS Trucks Hybrids? NewBizViews. Retrieved from http://www.newbizviews.com/2010/08/26/why-aren%E2%80%99t-all-ups-trucks-hybrids/

Rogers, E. M. (2003). *Diffusion of Innovations*. *New York* (5th Editio.). Free Press - a Division of Simon & Schuster Inc.

Roland Berger Strategy Consultants. (2010). *Powertrain 2020: Li-Ion batteries - the next bubble ahead?* Retrieved from http://www.rolandberger.com/media/pdf/Roland_Berger_Li-Ion_batteries_20100222.pdf

Roland Berger Strategy Consultants. (2011). *Automotive landscape 2025 : Opportunities and challenges ahead*. Retrieved from http://www.rolandberger.com/media/pdf/Roland_Berger_Automotive_Landscape_2025_20110228.pdf

Routledge, J. (2007). The decision to enter voluntary administration: Timely strategy or last resort? *Journal of Law and Financial Management*, *6*(2), 2. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1123047

Roxborough, S. (2012). Commercial Vehicle Shift Spurs CNG Mini-Boom. *EnergyBoom*. Retrieved from http://www.energyboom.com/print/244694

Ryttberg, K., & Törnlöf, S. (2006). *Supplying the latino way; A study of the Mexican automotive industry*. *International Business*. Jönköping University. Retrieved from http://his.diva-portal.org/smash/get/diva2:4053/FULLTEXT01

Sadiq, S., Pritchard, E., Dulaney, K., & Emadi, A. (2007). Plug-In Hybrid Market Transformation by Leveraging a Niche Market: School Buses. *2007 IEEE Vehicle Power and Propulsion Conference*, 483–492. doi:10.1109/VPPC.2007.4544173

Samaras, C., & Meisterling, K. (2008). Life cycle assessment of greenhouse gas emissions from plug-in hybrid vehicles: implications for policy. *Environmental science & technology*, *42*(9), 3170–6. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18522090

Sanna, L. (2005). Driving the solution, the plug-in hybrid vehicle. *EPRI journal*, 8–17. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Driving+the+solution,+the+plug-in+hybrid+vehicle#0

Santini, D., & Vyas, A. (2008). How to Use Life Cycle Analysis Comparisons of PHEVs to Competing Powertrains. *8th International Advanced Automotive Battery and Ultracapacitor Conference, Tampa, Florida*. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:How+to+Use+Life+Cycle+Analysis+Comparisons+of+PHEVs+to+Competing+Powertrains#0

Santoro, M. (1999). A Hybrid-Propulsion Powertrain with Planetary Gear Set for a 4WD Vehicle : Analysis of Power Flows and Energy Efficiency. Dresden. Retrieved from http://leonemar.din.uniroma1.it/sipre3_santoro.pdf

Savagian, P. (2009). *Driving the Volt - An Extended-Range Electric Vehicle*.

Schafer, A. (2004). Passenger Demand for Travel and Energy Use. *Encyclopedia of Energy* (Vol. 4, pp. 793–804). Elsevier.

Schey, S. (2009). *Electric Vehicle Charging Infrastructure Deployment Guidelines British Columbia*. Retrieved from http://www.bchydro.com/etc/medialib/internet/documents/environment/EVcharging_infrastructure_guidelines09.Par.0001.File.EV Charging Infrastructure Guidelines-BC-Aug09.pdf

Schoenberger, R. (2012). Azure Dynamics files for bankruptcy protection in Canada ; company coverted Ford vans from Avon Lake into hybrids. *The Plain Dealer. Cleveland Live LLC*. Retrieved March 27, 2012, from http://www.cleveland.com/business/index.ssf/2012/03/azure_dynamics_files_for_bankr.html

Schubert, R., Fable, S., & others. (2005). Comparative Costs of 2010 Heavy-Duty Diesel and Natural Gas Technologies: Final Report. *Comparative and General Pharmacology*. Cupertino, California: California Natural Gas Vehicle Partnership.

Schuh, G., Kampker, a., Burggraf, P., & Nee, C. (2011). Production system with respect for variable quantities for an economical electric vehicle production. *2011 IEEE International Conference on Industrial Engineering and Engineering Management*, 1123–1128. doi:10.1109/IEEM.2011.6118090

Schulz, D. A., Berlin, T. U., & Marker, S. (2010). Entering the electric mobility market : an analysis of commercial vehicle fleets Characteristics of commercial fleets. *VDE-Kongress 2010* (pp. 1–6). VDE VERLAG GmbH. Retrieved from http://www.vde-verlag.de/proceedings-en/453304047.html

Seetharaman, D. (2012, March 31). Ford pools EV, hybrid research as fuel prices jump. *Automotive News*. Retrieved from http://www.autonews.com/article/20120331/OEM05/120339982#ixzz1qqpaVjA0

Serrao, L. (2009). *A comparative analysis of energy management strategies for hybrid electric vehicles*. THE OHIO STATE UNIVERSITY. Retrieved from http://gradworks.umi.com/33/75/3375775.html

Shahidinejad, S., Bibeau, E., & Filizadeh, S. (2010). Statistical Development of a Duty Cycle for Plug-in Vehicles in a North-American Urban Setting Using Fleet Information. *Vehicular Technology, IEEE Transactions on*, *59*(99), 1. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5530421

Shankleman, J. (2011). Could Modec crash kill off UK's commercial electric vehicle market? *Guardian Environment Network*. Guardian News and Media Limited.

Shepardson, D. (2012, March 27). EV firm files for bankruptcy, lays off 50 Oak Park workers. *Detroit News*. Detroit, MI. Retrieved from http://www.detroitnews.com/article/20120327/AUTO0102/203270455

Shiau, C. S. N., Samaras, C., Hauffe, R., & Michalek, J. (2009). Impact of battery weight and charging patterns on the economic and environmental benefits of plug-in hybrid vehicles. *Energy Policy*, *37*(7), 2653–2663. doi:10.1016/j.enpol.2009.02.040

Silva, C., Ross, M., & Farias, T. (2009). Evaluation of energy consumption, emissions and cost of plug-in hybrid vehicles. *Energy Conversion and Management*, *50*(7), 1635–1643. doi:10.1016/j.enconman.2009.03.036

Simanaitis, D. (2007, April). 2006 DHL Sprinter vs. 2007 Fed-Ex W700 Hybrid vs. 2006 UPS Sprinter P57D - Special Report. *Road & Track*. Retrieved from http://www.roadandtrack.com/special-report/2006-dhl-sprinter-vs.-2007-fed-ex-w700-hybrid-vs.-2006-ups-sprinter-p57d

Simpson, A. (2006). Cost-benefit analysis of plug-in hybrid electric vehicle technology. *22nd International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium and Exhibition (EVS-22)*. National Renewable Energy Laboratory. Retrieved from http://ecoseed.org/whitePapers/Green-Tranportation-BEV_Cost-Benefit-Analysis-of-Plug-In-Hybrid-Electric-Vehicle-Technology.pdf

Simpson, S. (2011). Azure Dynamics quadruples its reach into US retail automotive market. *Vancouver Sun*. Retrieved from http://www.vancouversun.com/sports/Azure+Dynamics+quadruples+reach+into+retail+automotive+market/4244482/story.html

Skalny, P. F., & McGrew, D. Z. (2010). *Advanced Vehicle and Power Initiative* (pp. 1–30). Tank-Automotive Research, Development & Engineering Center (TARDEC). Retrieved from http://www.stormingmedia.us/95/9541/A954135.pdf

Smeltzer, L. R., & Siferd, S. P. (1998). Proactive Supply Management : The Management of Risk. *International Journal of Purchasing and Materials Management*, *34*(1), 38–45. doi:10.1111/j.1745-493X.1998.tb00040.x

Smith Electric Vehicles. (2010). *Delivering Green Now*. Smith Electric Vehicles.

Smith Electric Vehicles Corporation. (2011a). *Form S-1 Registration Statement*. *Exchange Organizational Behavior Teaching Journal* (Vol. 0508). US Securities and Exchange Commission. Retrieved from http://www.sec.gov/Archives/edgar/data/1455900/000104746911009328/a2206090zs-1.htm

Smith Electric Vehicles Corporation. (2011b). Smith Edison - Key Specifications. Retrieved August 16, 2012, from http://smithelectric.com/wp-content/themes/barebones/pdfs/SmithEdisonSpecSheet_OUS_2011.pdf

Smith Electric Vehicles Corporation. (2012). Smith Electric Vehicles Launches Production of All-Electric Newton Step Van. *Marketwatch.com*. Retrieved from http://www.marketwatch.com/story/smith-electric-vehicles-launches-production-of-all-electric-newtontm-step-van-2012-03-06

Smith, J. W. (2007). *Advanced Battery Technologies in EV , PHEV , and Stationary Applications at Southern California Edison*. Advanced Vehicle Innovations Consortium (AVI). Retrieved from http://www.plugincenter.com/files/documents/Jordan_Smith_Battery.pdf

Smolda, W. (2010). Fleet Sourcing Decisions: It’s a New World. *FleetBlogs.com*. Bobit Business Media. Retrieved from http://www.fleetblogs.com/waynesworldblog/2010/10/29/fleet-sourcing-decisions-its-a-new-world/

Solectria Renewables LLC. (2010). Solectria Renewables History. Solectria Renewables LLC. Retrieved from http://www.solren.com/history.html

Sondhi, K. (2011). *Electrification of Transportation*. Federal Express. Retrieved from http://nyclhvcc.org/wp-content/uploads/2010/06/FedEx-4-11-11.pdf

Sorensen, D. (2006). *The Automotive Development Process - A Real Options Analysis*. (B. Siegel & N. Schweitzer, Eds.) (1st Ed.). Deutscher Universitäts-Verlag GWV Fachverlage GmbH. Retrieved from http://www.amazon.com/Automotive-Development-Process-Options-Analysis/dp/3835004999

Southern California Edison. (2005). SCE Participates in Sprinter Van Project. *Current - Electric Transportation News From Southern California Edison*, *8*(4). Retrieved from http://www.sce.com/NR/rdonlyres/27E5ABE8-4AE2-4C98-808E-E4E11CF06CF8/0/ElectricTransportationSCEVol84.pdf

Sperling, D. (2011). Electric Dreams. *Technology Review*, (January/February 2011). Retrieved from http://www.technologyreview.com/energy/26970/

Srivastava, A. K., Annabathina, B., & Kamalasadan, S. (2010). The Challenges and Policy Options for Integrating Plug-in Hybrid Electric Vehicle into the Electric Grid. *The Electricity Journal*, *23*(3), 83–91. doi:10.1016/j.tej.2010.03.004

Stephan, M., & Feller, A. (2009). *Migrating from Oil-to Electricity-Powered Vehicles: Modeling Germany’s Transition to the EV until 2040 in System Dynamics*. Otto Beisheim School of Management Vallendar Vallendar, Germany. Retrieved from http://www.whu.edu/cms/fileadmin/redaktion/Startseite/PDF_s/2009_PDF_s/WHU_Study_Electric_Vehicles_08-2009.pdf

Stone, M., & Ozimek, J. F. (2011). *Smart Home , Smart Grid , Smart City*. Retrieved from http://store.business-insights.com/Product/?productid=BI00036-015

Straight, B. (2012). One Step at a Time. *FleetOwner*. Retrieved from http://fleetowner.com/print/running-green/one-step-time?page=2 3/15/2012

Struben, J. (2008). The diffusion of complex market technologies: From stylized facts to multiple mechanisms. *Industry Studies*. Retrieved from http://web.mit.edu/is08/pdf/Struben AE Diffusion_ISconf.pdf

Sturgeon, T. J. (2009). The North American automotive value chain : Canada's role and prospects Johannes Van Biesebroeck Gary Gereffi. *International Journal of Technological Learning Innovation and Development*, *2*(1/2), 25–52. Retrieved from http://www.cggc.duke.edu/pdfs/IJTLID_CanadasroleinNAautovaluechain_Sturgeon_2009.pdf

Sturgeon, T. J., Memedovic, O., Van Biesebroeck, J., & Gereffi, G. (2009). Globalisation of the automotive industry : main features and trends. *International Journal of Technological Learning Innovation and Development*, *2*(1/2), 7–24. Retrieved from http://www.cggc.duke.edu/pdfs/IJTLID_Globalizationofautoindustry_Sturgeon_2009.pdf

Suizo, G. L. (2010). Gas vs. Hybrids - Which is Better Suited For Your Fleet? *Automotive Fleet*, (August), 2010–2010. Retrieved from http://www.automotive-fleet.com/Channel/Green-Fleet/Article/Story/2010/08/Gas-vs-Hybrids-Which-is-Better-Suited-for-Your-Fleet.aspx

Sullivan, J., Salmeen, I., & Simon, C. P. (2009). *PHEV marketplace penetration: An agent based simulation*. University of Michigan, Ann Arbor, Transportation Research Institute. Retrieved from http://deepblue.lib.umich.edu/handle/2027.42/63507

Sullivan, L. P. (2010). VIDEO : Bryan Hansel on Fleets of EVs and Obama's Visit . *EnergyNOW!* Clean Skies Network LLC. Retrieved from http://www.energynow.com/video/2010/11/19/bryan-hansel-experience-ev-fleet-truck#

Sullivan, R. (2007). *Plug-in hybrid electric vehicle R & D Plan*. *US Department of Energy, PHEV Stakeholders Meeting*. US Department of Energy. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Plug-In+Hybrid+Electric+Vehicle+R&D+Plan#7

SustainableBusiness.com. (2011). NY State Spurs Commercial Fleets to Transition to Electric. SustainableBusiness.com. Retrieved from http://www.sustainablebusiness.com/index.cfm/go/news.display/id/23163

Swail, S. A. (2009). *Toward A New Economy*. San Francisco State University. Retrieved from http://scottswail.blogspot.com/2009/03/plug-in-hybrid-electric-vehicles-in.html

Synovate Motoresearch. (2007). Perceptions & Realities - Consumer Attitudes toward Advanced Propulsion Technologies & Alternative Fuels. *SAE 2007 Hybrid Symposium*. Synovate Motoresearch.

Sánchez, A. M., & Pérez, M. P. (2005). Supply chain flexibility and firm performance: A conceptual model and empirical study in the automotive industry. *International Journal of Operations & Production Management*, *25*(7), 681–700. doi:10.1108/01443570510605090

Sörensen, D. (2006). *The Automotive Development Process: A Real Options Analysis*. (B. Siegel & N. Schweitzer, Eds.) (1st Ed.). Wiesbaden: Deutscher Universitäts-Verlag GWV Fachverlage GmbH. doi:10.1007/978-3-8350-9339-3

Tamor, M. (2007). Beyond Hybrids : Ford's Global Approach to Sustainable Mobility. *SAE Hybrid Symposium 2007*. SAE International.

Tanfield Group PLC. (2009). *Tanfield Group PLC, Report And Financial Statements 2009*. Retrieved from http://www.tanfieldgroup.com/downloads/2009 Annual Report & Accounts FINAL.pdf

Tanfield Group PLC. (2010). *Tanfield Group PLC - Conditional Offer for Smith Electric Vehicle division.* Tanfield Group PLC. Retrieved from http://online.hemscottir.com/ir/tan/ir.jsp?page=news-item&item=362338473486038

Tarascon, J.-M., & Armand, M. (2001). Issues and challenges facing rechargeable lithium batteries. *Nature*, *414*(November).

Technology Review. (2011). THE PRICE OF BATTERIES Although costs are uncertain , they will be key to the success of electric cars . *Technology Review*, (January/February 2011), 61. Retrieved from http://www.technologyreview.com/files/49959/Jan11 Feature Electric Cars p61.pdf

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *The Theoretical Context of Strategic Management* (Vol. 15, pp. 285–305). Elsevier. Retrieved from http://www.sciencedirect.com/science/article/pii/0048733386900272

Thackeray, M. M. (2004). Batteries , Transportation Applications. *Encyclopedia of Energy* (Vol. 1, pp. 127–139). Elsevier. Retrieved from http://www.uns.ethz.ch/edu/teach/bachelor/energmob/Encycl-o-E_batteries_transportation.pdf

The Climate Group. (2012). *Plugged-In Fleets - A guide to deploying electric vehicles in fleets*. *Business*. Retrieved from http://www.theclimategroup.org/publications/2012/2/21/pluggedin-fleets-a-guide-to-deploying-electric-vehicles-in-fleets/

Thibaut, K. (2010). GM To Unveil Voltec Cargo Van Concept Tomorrow. *CrunchGear*, 265319–265319. Retrieved from http://www.crunchgear.com/2010/09/22/voltec-cargo-van-concept/

Thiel, C., Perujo, A., & Mercier, A. (2010). Cost and CO2 aspects of future vehicle options in Europe under new energy policy scenarios. *Energy Policy*, *38*(11), 7142–7151. doi:10.1016/j.enpol.2010.07.034

Thomas, C. E. (2009a). Fuel cell and battery electric vehicles compared. *International Journal of Hydrogen Energy*, *34*(15), 6005–6020. doi:10.1016/j.ijhydene.2009.06.003

Thomas, C. E. (2009b). Transportation options in a carbon-constrained world: Hybrids, plug-in hybrids, biofuels, fuel cell electric vehicles, and battery electric vehicles. *International Journal of Hydrogen Energy*, *34*(23), 9279–9296. doi:10.1016/j.ijhydene.2009.09.058

Thomas, C. E. (2009c). Cost-Benefit Analyses of Alternative Light-Duty Transportation Options for the 21st Century. *National Hydrogen Association Conference, Columbia, SC, March*, *31*. Retrieved from http://cleancaroptions.com/C.E._Thomas_NHA_Final_April_2009.pdf

Torrie Smith Associates. (2001). *Greening the Canadian Courier Fleet – Strategies for Improved Fuel Efficiency*.

Toulson, E. (2008). Evaluation of a hybrid hydraulic launch assist system for use in small road vehicles. *Industrial Electronics, 2008. ISIE 2008. IEEE International Symposium on* (pp. 967–972). IEEE. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4677190

Transport Canada Policy Group. (2001). *Canadian Courier Market Size, Structure And Fleet Analysis Study*. Retrieved from http://www.tc.gc.ca/pol/EN/Report/Courier2001/C2.htm

Trudell, C., & Ohnsman, A. (2012). Chrysler to Begin Natural-Gas Truck Sales to Fleets This Year. *BusinessWeek*. Bloomberg BusinessWeek. Retrieved from http://www.businessweek.com/news/2012-01-17/chrysler-to-begin-natural-gas-truck-sales-to-fleets-in-2012.html

Turrentine, Thomas. (2011). *Plug-In Hybrid Electric Vehicle Research Roadmap*. Retrieved from http://www.google.ca/url?q=http://www.energy.ca.gov/2010publications/CEC-500-2010-039/CEC-500-2010-039.pdf&sa=U&ei=0tw9TrvaF8jjiAKGyZHDBg&ved=0CBMQFjAA&sig2=hMJWkDsic4AsJQz2qCMIEA&usg=AFQjCNF8Yv3gyH96ok2RnfGeueezMryHpQ

Turrentine, Tom. (2007). The Market for Plug-in Hybrid Electric Vehicles. *Power Up! Summit 2007*. UC Davis, Institute of Transportation Studies. Retrieved from http://www.plugincenter.com/files/documents/TomTurrentine.pdf

U.S. Energy Information Administration. (2010a). *Annual Energy Review 2009*. Retrieved from http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf

U.S. Energy Information Administration. (2010b). *International Energy Outlook 2010*. Retrieved from http://www.eia.doe.gov/oiaf/ieo/

U.S. House of Representatives. (2006). *Hybrid Technologies For Medium- To Heavy-Duty Commercial Trucks*. *Science* (Vol. 2006).

UK Department for Business Innovation & Skills. (2011). *Business Action to Influence Consumer Demand for Low-carbon Goods and Services - Appendix B: Case Study 1: Modec* (pp. 68–156). Retrieved from http://www.bis.gov.uk/assets/biscore/business-sectors/docs/b/10-1100d-business-action-to-influence-consumer-demand-case-studies.pdf

US Departiment of Energy - Energy Efficiency & Renewable Energy. (2009). United Parcel Service Evaluates Hybrid Electric Delivery Vans. US Department of Energy. Retrieved from http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/47327.pdf

US Departiment of Energy - Energy Efficiency & Renewable Energy. (2010a). *Hybrid Electric Systems: Goals, Strategies, and Top Accomplishments*. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/hybrid_elec_sys_goals.pdf

US Departiment of Energy - Energy Efficiency & Renewable Energy. (2010b). DOE Awards $2.4 Billion for U.S. Batteries and Electric Vehicles. *EERE News*. Retrieved from http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=12710 10/16/2010

US Department of Energy - Energy Efficiency & Renewable Energy. (2011a). USPS eLLV Conversion Fleet. *Metro*. US Department of Energy - Energy Efficiency & Renewable Energy. Retrieved from http://avt.inl.gov/pdf/fsev/usps/USPSSummaryReportJuly2011.pdf

US Department of Energy - Energy Efficiency & Renewable Energy. (2011b). National Clean Fleets Partnership. US Department of Energy - Energy Efficiency & Renewable Energy. Retrieved from http://www1.eere.energy.gov/cleancities/pdfs/49539.pdf

US Department of Energy - Energy Efficiency & Renewable Energy. (2011c). Project Results : Evaluating FedEx Express Hybrid-Electric Delivery Trucks. US Department of Energy - Energy Efficiency & Renewable Energy. Retrieved from http://www.nrel.gov/docs/fy11osti/50042.pdf

US Department of Energy. (2006). *Roadmap and Technical Whitepapers - Appendix of Supporting Information*. US Department of Energy, 21st Century Truck Partnership. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ctp_roadmap_appendix_2007.pdf

US Department of Energy. (2007). *21st Century Truck Partnership, Roadmap and Technical White Papers*. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/21ctp_roadmap_appendix_2007.pdf

US Department of Energy. (2009a). *Recovery Act Awards For Electric Drive Vehicle Battery And Component Manufacturing Initiative*. Retrieved from http://www1.eere.energy.gov/recovery/pdfs/battery_awardee_list.pdf

US Department of Energy. (2009b). *FY 2009 Annual Progress Report for Advanced vehicle technology analysis and evaluation activities and heavy vehicle systems optimization program*. US Department of Energy. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/2009_avtae_hvso.pdf

US Department of Energy. (2010). *Clean Cities' Guide to Alternative Fuel and Advanced Medium- and Heavy-Duty Vehicles (Brochure)*. Retrieved from http://www.osti.gov/bridge/servlets/purl/990514-auW62E/990514.pdf

US Department of Energy. (2011). DOE Announces 6 New Corporate Partners Join the National Clean Fleets Partnership Companies to work with DOE to significantly reduce gasoline and diesel use in. US Department of Energy. Retrieved from http://energy.gov/articles/doe-announces-6-new-corporate-partners-join-national-clean-fleets-partnership

US Department of Energy - Energy Efficiency & Renewable Energy. (2012). *Fiscal Year 2011 Annual Progress Report For Energy Storage R&D*. Retrieved from http://www1.eere.energy.gov/vehiclesandfuels/resources/vt_es_fy11.html

US Department of Energy, AVTA. (2005). Comparing Energy Costs per Mile for Electric and Gasoline-Fueled Vehicles. Idaho National Laboratory. Retrieved from http://avt.inel.gov/pdf/fsev/costs.pdf

US Department of Energy, E. I. A. (2009). *Annual Energy Outlook 2009 With Projections to 2030* (Vol. 0383).

US Department of Energy, Energy Information Administration. (2011). *Annual Energy Outlook 2011* (Vol. 0383).

US Department of Energy National Renewable Energy Laboratory. (2011). Press Release: Gasoline Hybrid Electric Delivery Vehicles Reduce Tailpipe Emissions While Maintaining Fuel Economy. US Department of Energy. Retrieved February 26, 2011, from http://www.nrel.gov/news/press/2011/941.html 2/23/2011

US Department of the Treasury. (2012). General Explanations of the Administration's Fiscal Year 2013 Revenue Proposals. Retrieved from http://www.treasury.gov/resource-center/tax-policy/Documents/General-Explanations-FY2013.pdf

Ungar, E., Mueller, H., & Smith, B. (2010). *Benefits and Challenges of Achieving a Mainstream Market for Electric Vehicles*. US Department of Energy, Vehicle Technologies Program. Retrieved from http://www.sentech.org/phev/pdfs/Sentech_Report_V8.pdf

University of California Berkeley. (2009). Tesla Motors Case Study Example -The Thirteenth Annual Investment Banking Case Competition - presented by Goldman, Sachs & Co. University of California Berkeley, Haas School of Business. Retrieved February 26, 2011, from http://www.haas.berkeley.edu/Undergrad/pdf/casecompetition/case.pdf

Utilimaster Division - Spartan Motors Inc. (2011). *Utilimaster & Reach Vehicle Overview*. *Fortune*. Retrieved from http://www.spartanmotors.com/images07/pdfs/UTM_Q1_2011_Presentation.pdf

UtilityProducts.com. (2012). Frito-Lay : Boston Streets Go Green Using Frito-Lay All-Electric Delivery Trucks. *Utility Products*. Close-Up Media, Inc. Retrieved from http://www.utilityproducts.com/news/2011/12/1566350472/frito-lay-boston-streets-go-green-using-frito-lay-all-electric-delivery-trucks.html

Valentine-Urbschat, M., & Bernhart, W. (n.d.). *Powertrain 2020 – The Future Drives Electric*. Retrieved from http://www.rolandberger.com/media/pdf/Roland_Berger_Powertrain_2020_20110215.pdf

Valley, S., & Group, N. T. (2012). The future for electric car start-up tech is in China.

Van Amburg, B. (2007). Effective Heavy-Duty Hybrid Market Development : The HTUF Commercial-Military Model. *EVS23 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium* (Vol. 91106). CALSTART. Retrieved from http://www.calstart.org/Libraries/Publications/Effective_Heavy-Duty_Hybrid_Market_Development-The_HTUF_Commercial-Military_Model.sflb.ashx

Van Amburg, B. (2009). On-Road Heavy Duty Vehicle Overview. *GreenTech Connect Forum 2009*. CALSTART. Retrieved from http://www.threesquaresinc.com/gtt/wp-content/uploads/2009/04/billvanamburg.pdf

Van Amburg, B., & Hall, J. (n.d.). *Speeding High Efficiency Truck Adoption : Recommended Policies , Incentives and Investments*. Retrieved from http://www.calstart.org/Libraries/Publications/Speeding_High-Efficiency_Truck_Adoption.sflb.ashx

Van Biesebroeck, J. (2006). The Canadian Automotive Market. *Trade Policy Research*, 187–340. Retrieved from http://www.international.gc.ca/trade-agreements-accords-commerciaux/assets/pdfs/JVB-en.pdf

Vardera, L. L. (2010). *The Electric Vehicle Market in the USA*. Retrieved from http://www.finpro.fi/documents/10304/7e13a754-1c32-46aa-9383-c6b5b6ff8d6c

Veloso, F. (2000). The automotive supply chain organization : Global Trends and Perspectives. *Forecast*. Retrieved from http://carnegie-mellon.academia.edu/FranciscoVeloso/Papers/187375/The_Automotive_Supply_Chain_Organization_Global_Trends_and_Perspectives

Veloso, F., & Fixson, S. (2001). Make – Buy Decisions in the Auto Industry : New Perspectives on the Role of the Supplier as an Innovator. *Technological Forecasting and Social Change*, *257*, 239–257. Retrieved from http://www.sciencedirect.com/science/article/pii/S0040162500000925

Veloso, F., Henry, C., Roth, R., & Clark, J. P. (2000). *Global Strategies for the Development of the Portuguese Autoparts Industry*. Lisboa: IAPMEI Instituto de Apoio às Pequenas e Médias Empresas e ao Investimento. Retrieved from http://carnegie-mellon.academia.edu/FranciscoVeloso/Papers/187374/Global_Strategies_for_the_Development_of_the_Portuguese_Autoparts_Industry

Veloso, F., & Kumar, R. (2002). *The Automotive Supply Chain : Global Trends and Asian Perspectives*. Retrieved from http://www.adb.org/Documents/ERD/Working_Papers/wp003.pdf

Vergels, F. (2005). *SUBAT - Sustainable Batteries, Action 8.1.B.1.6 Assessment of Environmental Technologies for Support of Policy Decision*. Retrieved from http://www.battery-electric.com/subatdocs/WP5-007.pdf

Voelcker, B. J., & Voelcker, J. (2008). Our First Electric Cars ... May Be Trucks. *IEEE Spectrum*, 1–4. Retrieved from http://spectrum.ieee.org/green-tech/advanced-cars/our-first-electric-carsmay-be-trucks

Voelcker, J. (2005). Top 10 tech cars [hybrid electric vehicles]. *IEEE Spectrum*, *42*(3), 22–30. Retrieved from http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=1402714

Voelcker, J. (2006). Driving GM's New Hydrogen Car. *IEEE Spectrum*, (September 2006), 1–6. Retrieved from http://spectrum.ieee.org/energy/renewables/driving-gms-new-hydrogen-car

Voelcker, J. (2008b). Plug-ins and Hybrids and Diesels, Oh My! *IEEE Spectrum*, 1–4. Retrieved from http://spectrum.ieee.org/energy/environment/plugins-and-hybrids-and-diesels-oh-my

Voelcker, J. (2013). Azure Dynamics Bankrupt, Built Ford Transit Connect Electric. *Green Car Reports*. Retrieved March 28, 2012, from http://www.greencarreports.com/news/1074610_azure-dynamics-bankrupt-built-ford-transit-connect-electric

Wagner, J. (2012). Postal Electric Vehicles. NYSERDA - New York State Energy Research & Development Authority. Retrieved from http://www.nyserda.ny.gov/en/Page-

Sections/Research-and-Development/Transportation/Transportation-Research/Postal-Electric-Vehicles.aspx

Walsh, B. (2012). Battery Warning: Why Sales of Electric Cars Have Yet to Take Off. *Time*. Retrieved from http://ecocentric.blogs.time.com/2012/01/06/battery-warning-why-electric-vehicles-have-yet-to-take-off/

Ward, J., & Davis, S. (2009). *2008 Vehicle Technologies Market Report*. Retrieved from http://www.osti.gov/energycitations/product.biblio.jsp?osti_id=979836

Warren, K. (2002). *Competitive Strategy Dynamics* (1st Ed., pp. 175–176). New York: Wiley.

Webb, A. (2012a). Demise of Azure Dynamics Casts Doubt on All Electric Retrofitters _ PluginCars.pdf. *PluginCars.com*. Retrieved August 30, 2012, from http://www.plugincars.com/demise-azure-dynamics-casts-doubt-all-electric-retrofitters-124110.html

Webb, A. (2012b). Smith Electric partnership with Wanxiang finds a sweet spot in China's EV plans. *ChinaEV Blog*. Retrieved August 6, 2012, from http://chinaev.wordpress.com/2012/08/06/smith-electric-partnership-with-wanxiang-finds-a-sweet-spot-in-chinas-ev-plans/

Weber, J. (2009). *Automotive Development Processes - Processes for Successful Customer Oriented Vehicle Development*. Springer. Retrieved from http://www.springerlink.com/content/l358g1/#section=724010&page=1

Wells, P., Gosbee, D., Flach, M., & Elwood, M. (n.d.). Webinar: Hybrid commercial vehicles : understanding the fuel and cost saving. AutomotiveWorld.com. Retrieved from http://www.automotiveworld.com/img/webinars/10-05-25-hybrid-commercial-vehicles.pdf

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180. doi:10.1002/smj.4250050207

Wery, R., & Derriennic, Y. (2010). Paving the Way for Electric Vehicles: A Trajectory for a 50% Cost Reduction by 2020. *Electrical Vehicle Plug and Play*. Bruxelles: PRTM Inc. Retrieved from http://ec.europa.eu/energy/technology/initiatives/doc/pv_implementation_plan_final.pdf

Williams, B., & Kurani, K. (2007). Commercializing light-duty plug-in/plug-out hydrogen-fuel-cell vehicles: "Mobile Electricity" technologies and opportunities. *Journal of Power Sources*, *166*(2), 549–566. doi:10.1016/j.jpowsour.2006.12.097

Williams, M. (2012). Electric Trucks May Shift EV Perceptions. *PickupTrucks.com*. Retrieved March 28, 2012, from http://news.pickuptrucks.com/2012/03/electric-trucks-may-shift-ev-perceptions.html 3/28/2012

Wind, Y., & Thomas, R. J. (1994). Segmenting Industrial Markets. *Advances in Business Marketing and Purchasing*, *6*, 59–82. Retrieved from http://marketing.wharton.upenn.edu/documents/research/9405_Segmenting_Industrial_Markets.pdf

Witzenburg, G. (2011). Ford's electric vehicle plans include consumer education; possibly a beefier plug-in hybrid. *AutoBlogGreen*. Retrieved from http://green.autoblog.com/2011/03/09/fords-electric-vehicle-plans-include-consumer-education-possib/

Woodall, B. (2010). Obama says electric car battery prices to tumble. *Reuters.com, Business & Financial News*. Retrieved from http://www.reuters.com/assets/print?aid=USN1521310320100715

Yamaguchi, J., Tabata, K., Sawato, M., Yamada, S., Itaya, M., Sun, J., Cho, A.-H., et al. (2009). *Electric Vehicles - Batteries not the only EV plays*. *October* (Vol. 1). Retrieved from http://www.zyen.info/joomla/londonaccord/images/reports/pdf/ev_creditsuisse_2009.pdf

Zeng, X. (2009). *Improving the Energy Density of Hydraulic Hybrid Vehicles (HHVs) and Evaluating Plug-In HHVs*. University of Toledo. Retrieved from http://etd.ohiolink.edu/view.cgi/Zeng Xianwu.pdf?toledo1239319863