Challenges and Considerations for Transitioning to an Electric Fleet in the Fire Service

WHITE PAPER

Paper Assembled By:

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Introduction

The information presented in this paper results from collaborative discussions among subject matter experts involved in fire apparatus specifications, acquisition, training, maintenance, and repair. While the insights and recommendations offered are grounded in professional experience and current knowledge, they should not be considered exhaustive or definitive. Many questions and aspects of electric fire apparatus integration, infrastructure upgrades, training and safety, and EV maintenance may require further investigation. Numerous studies and research areas beyond the scope and expertise of this group need to be addressed to fully understand and advance the field.

The introduction of electric vehicles (EVs) has sparked interest in various sectors, including emergency services such as firefighting. Electric fire apparatus, which includes fire trucks and other firefighting vehicles powered by electric motors and batteries, represent a potential shift towards sustainable and environmentally friendly firefighting operations. This paper explores the pros and cons of electric fire apparatus and discusses various points and concerns that must be considered in the context of fire service operations and EV maintenance and repairs. It is important to note that this paper is not exhaustive and may not cover every aspect or unique scenario relevant to all organizations. We strongly encourage agencies to review this information as a potential guide and consult additional resources or experts to ensure thorough understanding and compliance with all applicable standards and regulations.

The electrification of the fire apparatus is here. To that end, the electric fire apparatus must perform or be more appointed to the tasks. When incorporating these electric vehicles into your fleet for emergency response, agencies must view electric fire apparatus as "All Risk/All Hazard" vehicles, and each apparatus, Type 1 through Type 6, Water Tender, Rescue, and all other like (EV) equipment must be able to perform any assigned task. As such, where an electric battery-powered fire apparatus is placed in service, it must be viewed as able to respond to any emergency response locally or regionally.

Most fire service apparatus today are diesel-powered. Only a rare few are primarily “battery powered”. Because each emergency fire apparatus is considered “All Risk”, they must be designed and specified with that in mind. Electric fire apparatus cannot simply stop functioning when the battery or batteries become depleted. Therefore, any responsible apparatus specification must include a backup system to keep the apparatus performing at its peak for as long as the task requires. Currently, the most common way to accomplish this is the use of an ICE (Internal Combustion Engine) or Range-Extended system as a backup to provide electricity for contiguous/continuous driving and pumping operations. Another option would be a parallel electric drive system, where a diesel engine and an electric motor work independently or together for propulsion and pumping operations. In either situation, a diesel or gas motor is utilized, working in combination with electric motors for extended operations. The primary fuels in use today for these systems are #2 Diesel and gasoline.

While electric fire apparatus may offer promising benefits such as environmental sustainability, possible reduced operating costs, and improved community relations through noise reduction, etc. some challenges must not be overlooked including limited range, high initial costs, and specific operational considerations that must be carefully evaluated by fire departments who are considering adoption.

As technology advances and infrastructure improves, electric fire apparatus may become increasingly viable options for enhancing firefighting capabilities while minimizing environmental impact. Keeping in mind that electric vehicles are not new to the modern world, the introduction of the electric fire apparatus is still viewed as “experimental” in the industry and many views are that it will take at least 10 or more years to gather enough information and technological improvements regarding “battery only apparatus” to bring the electric fire apparatus to a point of ability to replace old petroleum-based fire apparatus with fully electric “All Risk” apparatus. Fire departments should first weigh the pros and cons carefully to determine the suitability of electric fire apparatus for their specific operational needs and contexts.

Pros of Electric Fire Apparatus

Environmental Benefits:

When used in all-electric operation, electric fire apparatus produce zero tailpipe emissions during operation, which may be viewed as also reducing the agency's "carbon footprint" and improving air quality in urban areas where fire stations are often located. Electric motors have fewer moving parts that are less likely to wear out, which may lead to lower maintenance costs. Electric motors themselves don't require oil changes, filter changes, or diesel exhaust fluid (DEF). Electric fire trucks can reduce tailpipe emissions and can help municipalities meet environmental goals. Firefighters are also less exposed to toxins in the air at the fire station, on scene, and at fueling centers.

Reduced Noise Pollution:

Electric motors are quieter compared to traditional diesel engines, which may be advantageous in some urban settings where noise reduction is important for community relations and firefighter communication. On-scene advantages include no diesel engine noise to contend with. While there will be some pump noise during fire suppression, it will be much quieter than the typical diesel engine. The reduction of noise is also a benefit to pedestrians, helping to reduce the noise pollution that is prevalent in urban settings.

Lower Operating Costs:

Electric vehicles may have lower fuel and maintenance costs over their lifetime compared to diesel or gasoline vehicles, possibly reducing long-term operating expenses for fire departments. An electric chassis, even one with a small ICE range extender-generator, in comparison, has fewer moving parts, less caustic and hazardous fluids, and minimal high-temperature exhaust or emission systems. Battery electric vehicles are expected to extend preventive maintenance (PM) schedules for items like brakes and tires. The potential exists for significant maintenance cost reductions with battery electric vehicles; however, current research indicates that maintenance reduction is not a near-term savings and that the early generation vehicles may be equal to, or worse than, competing diesel vehicles, specifically with regard to replacement of the vehicle batteries.

Energy Efficiency:

Electric motors are more energy-efficient than internal combustion engines, converting a higher percentage of electrical energy into motion, which could lead to longer operational ranges and reduced energy consumption. Electric motors can convert up to 95% of the energy they draw into power, while diesel engines convert only 20–30%.

Potential for Integration with Renewable Energy:

Fire stations equipped with solar panels or other renewable energy sources can charge electric fire apparatus using clean energy, further reducing environmental impact. Solar power may help fire departments save money and optimize energy savings while also providing resiliency in the event of a power outage. Charging an electric vehicle with solar power is the cleanest and most cost-efficient way to charge an electric vehicle, but it also comes at a price.

Technological Advancements:

Electric vehicles often come equipped with advanced technological features such as regenerative braking, telemetry for diagnostics, and connectivity options that can enhance vehicle performance and maintenance.

Public Perception:

Adopting electric fire apparatus can improve the public image of fire departments as forward-thinking and environmentally responsible organizations. An electric fire truck makes a great press release and a great talking point.

Cons of Electric Fire Apparatus

Limited Range and Charging Infrastructure:

Current battery technology limits the operational range of electric fire apparatus compared to traditional vehicles. Electric fire apparatus in service currently, have an "electric only" range of 35 to 60 miles. This of course will vary based on the design and specifications of the apparatus and as technology continues to evolve. Additional batteries will provide additional range but will also come at an additional cost. While that may sound low, it's important to remember that most urban fire departments in larger cities cover a fairly small radius. Generally speaking, electric apparatus is more economical in urban city environments, while diesel-powered apparatus will be more efficient over long distances and extended emergencies. However, fire departments will need to make significant investments in charging infrastructure and manage vehicle downtime during charging.

Initial Cost:

Electric vehicles generally have a higher upfront cost than their diesel or gasoline counterparts, which can be a barrier to adoption for cash-strapped fire departments. The price of an electric fire truck can be 40–50% or more than a diesel fire truck. Some electric fire trucks cost upwards of $1.85 million, which is almost double the price of some traditional fire apparatus that cost $900,000–$1.3 million. Fire stations that are currently equipped with backup generators in case of power outages may also need to be taken into consideration as the current generator may not be of sufficient voltage to provide the necessary means for vehicle charging. To appropriately power a fire station, it will need enough 480-volt three-phase power to support the charging infrastructure. This is standard for any commercial power requirements. If 480-volt power is not available, this power requirement can be accomplished with a step-up transformer. Agencies must consider this additional expense when planning to integrate electric fire apparatus into their fleet. This additional expense could add hundreds of thousands of dollars to install within each fire station that is equipped with electric fire apparatus.

Weight and Payload Capacity:

Batteries are heavy, and this weight can impact the payload capacity of fire apparatus. EV batteries can add up to 40% more weight to a vehicle than internal combustion engine (ICE) vehicles. Fire departments may need to compromise on equipment and water-carrying capacity to accommodate batteries.

Additional impacts regarding tires should also not be overlooked. Tires engineered for EV placement may improve EV performance by ensuring the longevity of these tires despite carrying heavier vehicle loads enabling these tires to better counter the higher torque of electric motors and their effect on traction. EV-rated tires are different from standard tires because they need to support the vehicle's weight, provide traction, and minimize rolling resistance. EV-rated tires are made with stronger compounds and have thicker sidewalls to support this weight.

Performance in Extreme Conditions:

Electric vehicles may experience reduced performance in extreme temperatures or during prolonged use, which is critical in firefighting scenarios where vehicles are subjected to intense operational conditions. This would be especially true for any electric fire apparatus that may be assigned to large complex fires for weeks to months on end. Fire departments must consider this and emphasize additional training for operators about monitoring the battery temperatures and verifying that any onboard battery thermal management systems are operating correctly. In addition, the NFPA committee has not considered electric vehicles in the pump testing standard. To be certified the pumping apparatus must pump for two hours straight at 100 percent capacity without refueling. The standard does not address whether the apparatus is running on diesel, hydrogen, CNG, or electricity, so it is left to the manufacturer to determine how they will certify the pump rating. A fully electric certification would need enough battery storage to make it through the first two hours of pumping. For most electric apparatus, this may require larger or additional batteries or smaller rated pumps to meet this standard.

Firefighter Training and Familiarity:

Electric fire apparatus requires specialized training for firefighters and maintenance personnel to understand new operational procedures, maintenance requirements, and safety considerations related to high-voltage systems. High-voltage systems on electric fire trucks are designed to be safe under normal operating conditions. However, the placement of high-voltage elements on fire apparatus can significantly affect firefighter and maintenance technician functionality, serviceability, and overall safety. Agencies must consider the additional OSHA/NFPA training that is required and the additional personal protective equipment and tools necessary for safe maintenance and repairs being performed on electric fire apparatus.

Battery Lifespan and Replacement Costs:

As electric vehicles (EVs) become increasingly common across various industries, the adoption of electric trucks for emergency services is gaining traction. These vehicles promise significant environmental and operational benefits, including reduced emissions and lower fuel costs. However, one of the most critical factors influencing their widespread adoption is the cost of the battery, which serves as the heart of any electric vehicle.

The lifespan of batteries in electric vehicles can be affected by frequent charging and discharging cycles. Replacing batteries is a significant cost factor that fire departments must consider. The U.S. Department of Energy predicts that EV batteries can last 8–10 years, some up to12 years in premium operational conditions. This means that electric fire apparatus will most likely incur at least one, if not more, main battery changeouts during the service life of the apparatus.

In an electric truck, especially one designed for emergency services, the battery is crucial. It must not only power the vehicle over long distances but also support various high-energy-demand systems like sirens, communication devices, and possibly medical equipment. As such, the battery's capacity (measured in kilowatt-hours, kWh) and its energy density are key determinants of both the vehicle's range and its ability to perform reliably under stressful conditions.

The cost of a battery for an electric truck is influenced by several factors:

- Larger capacity batteries that offer longer ranges or higher power output typically cost more. For larger trucks, batteries can range from 300 kWh to over 1000 kWh, depending on the vehicle's intended use and required range.
- The type of battery chemistry used also can significantly impact cost. Lithium-ion batteries are currently the most common, but advances in solid-state batteries or other chemistries may alter cost dynamics in the future.
- The scale of battery production affects unit costs. As more manufacturers produce batteries, the cost per unit decreases due to economies of scale.
- The availability and cost of raw materials like lithium, cobalt, and nickel can fluctuate, impacting battery prices. Additionally, geopolitical issues can affect supply chains, leading to potential cost increases.
- As battery technology evolves, improvements in energy density, charging times, and lifecycle management can reduce overall costs.

While it is impractical for us to predict the actual replacement cost for batteries for an electric fire apparatus, one can consider as reference only, the current average cost per kWh for electric truck batteries.

As of 2024, the cost of batteries for electric vehicles is typically around $100 to $150 per kWh but can cost upwards of $200 or more per kWh for heavy trucks. For an electric emergency vehicle with a battery capacity of 300 to 500 kWh, this translates to a battery cost possibly ranging from $50,000 to $75,000. However, if the vehicle requires a more advanced battery with higher energy density or additional features to support emergency services, the cost could be significantly higher.

Other considerations include the cost and regulations for disposal of the old batteries as lithium batteries are considered hazardous waste and are subject to DOT's Hazardous Materials Regulations for disposal. Most, however, are recyclable and depleted batteries do still retain some value towards recycling.

While the upfront cost of the battery is substantial, it's important to consider the total cost of ownership (TCO) over the vehicle's lifespan. Factors that offset the high initial cost include:

- *Lower Fuel Costs:* Electric vehicles typically have lower energy costs compared to diesel-powered counterparts.
- *Reduced Maintenance:* Electric drivetrains have fewer moving parts, leading to lower maintenance costs.
- *Incentives and Rebates:* Many governments offer subsidies, tax incentives, and rebates for electric vehicle purchases, which can significantly reduce the effective cost of the battery.

The cost of batteries is expected to continue declining as technology advances and production scales up. By 2030, some experts predict that battery prices could drop to as low as $60 per kWh, making electric trucks even more financially viable for emergency services.

The cost of the battery remains a significant consideration for the adoption of electric emergency vehicles. While the upfront expense is high, the long-term savings and benefits, coupled with decreasing battery prices, may make them an increasingly attractive option. As technology continues to evolve, the cost-benefit equation will likely tip further in favor of electric vehicles, paving the way for a greener and more efficient future in emergency services.

Grid Demand and Charging Challenges:

Charging multiple electric fire apparatuses simultaneously can strain local electrical grids, especially in areas with inadequate infrastructure to support high-power charging needs. The time it takes to charge an electric fire truck can be problematic. Additional issues are with the availability of charging stations. The U.S. electrical systems are not expanding fast enough to meet rapidly growing power needs and agencies must consider this when integrating electric fire apparatus into their fleet.

Additional Considerations

When a fire agency is planning the purchase of electric fire apparatus, there are several important additional considerations to include in the decision-making process. These considerations cover various aspects from the vehicle itself to the necessary infrastructure upgrades. The following is a comprehensive list of considerations that an agency should review when discussing the purchase of electric fire apparatus. This list is intended to provide a foundational overview of the topic at hand. It's important to note that this list represents only a partial selection of relevant information and may not encompass all necessary elements. Due to the complexity and evolving nature of the subject, additional research and investigation may be required to obtain a complete understanding of questions that arise. We encourage agencies to delve further and explore additional resources to ensure agencies will have the most thorough and up-to-date information available.

Pilot Programs:

Initiate pilot programs to test electric fire apparatus in different operational environments and assess their performance over time, i.e.:

- Diverse Environment Testing Program
- Extended Duration Performance Monitoring
- High-Intensity Response Simulation
- Operational Flexibility and Adaptation Testing
- Battery and Charging Infrastructure Stress Test
- Urban vs. Rural Deployment Study
- Extreme Weather Performance Program
- Night and Day Operational Testing
- High Altitude Performance Evaluation
- Maintenance and Repair Tracking
- Cross-Departmental Integration Study

Infrastructure Investment:

Invest in charging infrastructure and renewable energy sources to support the adoption of electric fire apparatus, i.e.:

- High-Speed Charging Stations
- Robust Electrical Upgrades
- Smart Charging Solutions
- Networked Charging Stations
- Emergency Charging Backup
- Public and Community Charging Access
- Renewable Energy Investments:
  - Solar Panels
  - Wind Turbines
  - Battery Storage Systems
  - Energy Efficiency Upgrades
  - Renewable Energy Purchase Agreements
  - Green Building Certifications

Training and Education:

Provide comprehensive training programs for firefighters and maintenance personnel to ensure they are proficient in operating and maintaining electric fire apparatus safely and effectively, i.e.:

Training Programs for Firefighters:

- Introduction to Electric Fire Apparatus
- Electric Vehicle Operation and Safety
- Emergency Response Procedures
- Battery Safety and Management
- Fire Department Protocols for Electric Apparatus
- Hands-On Drills and Simulations

Training Programs for Maintenance Personnel:

- Electric Fire Apparatus Maintenance Fundamentals
- Advanced Electric Vehicle Systems
- Battery Maintenance and Troubleshooting
- Safety Procedures and Emergency Protocols
- Software and Diagnostic Tools Training
- Preventive Maintenance and Inspection Procedures
- Manufacturer-Specific Training

Other Considerations:

- *Certification Programs*: Offer certification upon completion of training programs to validate proficiency and ensure a standard level of competency.

- *Ongoing Education*: Implement continuous education and refresher courses to keep personnel updated on new technologies, techniques, and best practices.
- *Collaboration with Manufacturers:* Work with manufacturers to ensure training aligns with the latest advancements and recommendations for electric fire apparatus.

Collaboration and Research:

Collaborate with manufacturers, researchers, and government agencies to address technological barriers and advance the development of electric fire apparatus tailored to the unique needs of the fire service. i.e.:

- Joint Development Projects
- Technology Integration
- Field Testing and Feedback
- Training and Support Programs
- Affordability of new Training Requirements and Programs
- Innovation and R&D Partnerships
- Academic Research Initiatives
- Technology Feasibility Studies
- Safety and Performance Evaluations
- Data Collection and Analysis
- Pilot Programs and Case Studies
- Regulatory and Standards Development
- Funding and Grants
- Public Policy Advocacy
- Emergency Response and Safety Programs

Vehicle Performance and Specifications:

Operational Range:

Evaluate the electric fire apparatus's range on a single charge and its suitability for typical response distances.

Payload Capacity:

Consider how battery weight may impact the vehicle's ability to carry firefighting equipment and water. Larger or more batteries will include additional weight and occupy additional space possibly impacting the size and type of equipment carried, and possibly affect the size of water/foam tanks, etc. Potential safety and risk factors for fire crews may be of concern due to the possibility of less tools and equipment carried or possible reduction in suppression capability.

Speed and Acceleration:

Assess the vehicle's ability to perform under emergency response conditions. A well performing apparatus is the dream of any Fire Chief, apparatus committee, firefighter and mechanic, however a potential safety consideration that must be included in driver operator training is, that electric fire apparatus can accelerate much faster than diesel fire trucks. Some electric fire trucks can accelerate from 0-50 miles per hour in 20-25 seconds. Agencies must consider this when developing driver training practices as aggressive driving behaviors are a significant contributor in apparatus involved accidents and this additional performance feature could become a potential safety concern particularly among inexperienced drivers.

Climate Suitability:

Consider how the vehicle performs in various weather conditions, including extreme hot or cold temperatures. Another environmental condition that should be taken into consideration is flooding situations where a battery pack may become submerged in water and the potential risks involved.

Initial Cost and Total Cost of Ownership:

Purchase Price:

Compare the upfront cost of the electric fire apparatus to traditional diesel or gasoline equivalents. Currently, pricing experience is largely based on prototype and pre-production experience and estimation. There are many variables including grants, tax breaks, and incentives. The industry is also developing alternatives to traditional purchasing or leasing.

Maintenance Costs:

When considering electric fire apparatus, agencies need to also estimate the maintenance expenses over the vehicle's lifecycle. Electric vehicles can potentially lower costs due to fewer moving parts. Electric drives are more energy efficient than diesel and the reduction in diesel-based friction-sensitive mechanical systems such as pumps, valves, transmissions, and belts should reduce maintenance and servicing. This trend is expected to continue with possible reductions in cost and significant gains in performance as technology advances. Diesel performance, in contrast, is unlikely to yield large gains in performance with reduced costs.

Resale Value:

Evaluate the vehicle's depreciation rate and potential resale value as the used electric vehicle is in its infancy. Residual value is a question. The value of electric motors and batteries in salvage may prove an advantage as they can be repurposed for non-vehicle uses and may have significant life left.

Infrastructure Requirements:

Charging Infrastructure:

Assess the need and costs for installing charging stations at fire stations, including other strategic locations owned by the agency as well as the inclusion of any backup/secondary electrical generating systems.

Electrical Upgrades:

Determine if electrical upgrades are necessary to support high-power charging infrastructure. Evaluate the electrical capacity of the fire station to determine if it can support high-power charging equipment for electric vehicles. This may be an additional cost to the agency.

Grid Capacity:

Consider the impact on local electrical grids and any necessary upgrades to accommodate multiple electric vehicles. Assess existing infrastructure and identify any necessary upgrades to accommodate electric fire apparatus charging needs.

High Voltage Electrical Safety Protocols:

Development of safety protocols for handling high-voltage systems and emergency procedures specific to electric vehicles. High-voltage systems are designed to be safe under normal operating conditions, but the placement of high-voltage elements (i.e. high voltage wiring, electric motors etc.) can significantly affect functionality, serviceability, and overall safety for maintenance personnel. Technicians must follow industry standard hazard protocols and use appropriate PPE when repairing high voltage equipment.

Agency Operational Considerations:

As presented in the introduction, it cannot be stressed enough, that agencies who are considering the integration of electric fire apparatus must conduct a thorough review and evaluation of how these vehicles will affect the operational aspects during extended emergency operations. All fire apparatus must be designed and specified as an all-risk vehicle. This includes any apparatus (Type 1, 3, 6), Trucks, Water Tenders, Staff (Command) Vehicles, etc. They all must be capable of extended operations in a variety of conditions including:

- Large structural fires
- Wildland Fires and Earthquakes
- Multiple issues including narrow roads with soft shoulders, bridge loads, isolated areas, causing potential undercarriage damage, damage to road and power infrastructure, etc.
- Floods where units may need to effect rescues in deep water.
- The required number of units at a large incident to be supported with charging requirements.
- Special equipment, PPE, and training for inspections or maintenance.
- High voltage safety concerns for under-chassis inspections during or after an incident while in demobilization.
- High voltage electrical repairs that are necessary maintenance or at an incident scene becomes a safety issue without necessary PPE.
- Temperature hot or cold can affect battery operations and the possible dangers of changing out the vehicle may become part of the problem versus part of the solution.
- Increased vehicle size and weight potentially require response limitations for roads, bridges, access, etc.

Conduct a Response Time Analysis:

Evaluate how charging times and vehicle availability may impact response times by gathering data on the current average response times for emergency calls using traditional fire trucks. Review various types of incidents to understand typical response times required and any time-sensitive factors involved. Determine the average time required to fully charge an electric fire truck while using available charging infrastructure.

Determine how Integration with Existing Fleet will be accomplished:

Consider compatibility and interoperability with existing firefighting equipment and protocols by:

- Assess Your Fleet and Operational Needs
- Select the Right Electric Fire Truck
- Upgrade Infrastructure
- Establish Costs
- Train Personnel
- Update Policies and Procedures
- Integrate with Existing Systems
- Monitor and Evaluate Performance
- Communicate with Stakeholders
- Review and Adapt

Develop Backup Plans:

Develop contingency plans for vehicle downtime due to charging or maintenance issues. i.e.:

- Establish Backup Vehicle Protocols
- Implement Efficient Charging Strategies
- Develop Maintenance and Repair Protocols
- Create Detailed Contingency Plans
- Improve Fleet Management
- Communication and Coordination
- Training and Drills
- Evaluate and Adapt

Light Duty / Support Vehicle Use & Outfitting

With the release of the Electric Fire Apparatus concept, also comes additional options that have become available in the all-electric and hybrid light duty emergency response and support vehicle marketplace. Please note that the same factors discussed will, for the most part, cover hybrid offerings.

These vehicle options are included below, but do not encompass every all-electric vehicle on the market. It does cover the majority of vehicles that have been considered for use in the emergency vehicle role. Some in this list are currently utilized among agencies across the nation and others might be in service for testing and/or are being marketed toward the emergency services marketplace. The vehicles in this list are also candidates for use as administrative or staff support vehicles that are not being used in emergency response.

Ford

- F150 Lighting Pickup
- Mustang Mach-E Car

Chevrolet

- Chevy Blazer EV SUV
- Silverado EV Pickup

GMC

- Hummer EV Pickup
- Hummer EV SUV

Rivian

- R1S SUV
- R1T Pickup

Tesla

- Cybertruck
- Model 3 Car
- Model S Car
- Model X Car
- Model Y Car

As per all of the pros and cons previously listed, each will translate to the light duty electric vehicle fleet and all of them need to be reviewed carefully. Please take time to review those while also taking into consideration the following points when specifying light duty-all electric vehicles:

Costs:

The costs of these vehicles in most, if not all cases, can be more than traditional gas- or diesel-powered vehicles. These costs, to include resale, need to be understood. Maintenance costs should also be considered. This is especially true if agencies perform their own maintenance in-house or if these specific vehicles will only be dealer maintained. In-house repairs will require added training for both maintenance and safety concerns presented with all electric platforms. Electric vehicles pose many new dangers and safety concerns which must not be overlooked.

Roles:

The specific roles and uses of these vehicles should be carefully considered before purchase. These might include distances to travel, available charging infrastructure, take home use, payment of take-home vehicle charging costs, install of added infrastructure to support these vehicles, operator training and many other factors that go outside of the scope of this document.

Upfitting Costs and Considerations for Light Duty Vehicles

(This section will cover information for both all electric and hybrid vehicle offerings)

Overall upfitting for both all electric and hybrid fleet vehicle offerings are similar to those of traditionally powered fleet vehicles, but as with all new vehicle platforms, there are some items that must be considered:

Vehicle Role and the electrical loads that vehicle will need to sustain:

Much like requirements for the all-electric or combined systems on large apparatus, light duty vehicles have similar limitations. One of those is the available battery capacity and the electrical loads that the vehicle will be required to support.

Some examples of these loads are:

- Emergency Lighting
- Radio Communications
- Support for data gateways / modems / laptops / docking station charging.
- Any and all other auxiliary loads that might be needed to perform the role of that vehicle:
    - Portable radio chargers
    - Flashlight chargers
    - Etc.

Each of these electrical loads are normally considered in traditionally powered vehicle platforms by qualified upfitters, but in the case of all electric or hybrid offerings these loads truly need to be specified to the nearest ampere load and evaluated before purchase of the vehicle. The load requirements can quickly exceed the capability of most, if not all vehicles currently on the market. These predetermined load capacities will quickly confirm if these vehicles will be viable in your fleet.

Picking the right vehicle upfitter:

Consideration must be given to the current training level, experience, and capabilities of the emergency vehicle upfitter. Based on these evaluations and discussions, it can be determined whether the upfitter is capable of safely and effectively outfitting your new all electric or hybrid vehicle purchase. Any lack of understanding of these vehicles may result in warranty issues or worse, potential situations that cause damage to the vehicle or vehicle destruction or potential loss of life.

Most cases where the electric vehicles are intended by the manufacturer to be used in the emergency vehicle marketplace, those manufacturers also support those vehicles by providing best practice scenarios and documentation for upfitters and body builders. Well-educated upfitters will have access to these documents and should be able to answer all your upfitting questions. These answers should be able to point you to the best solution for your agency. If those answers cannot be clearly given or suitable references cannot be supplied, it is suggested to re-evaluate your upfitter choices.

Choosing equipment solutions before vehicle purchase:

It is very important to know if aftermarket companies have designed the emergency equipment to work with your vehicle choices. This has come to the forefront in the past 4-5 years with the increase in agencies using any vehicles they can find due to vehicle shortages and extended delivery times for vehicles. This is true to any and all vehicle choices that are not specifically designed for fleet or (SSV) Special Service use.

The most common occurrence of this is when a dealer cannot provide a SSV (Special Service Vehicle) version of a specific model but can offer the civilian version. Many less experienced purchasers might think those two vehicles are built the same since they have the same name. Usually, they are not. Also, in many cases the aftermarket might only support the SSV version and might not support the civilian version at all. In these cases, you should know that upfitting costs can increase greatly due to the need to custom make solutions for the non SSV version of the vehicle. This is especially true with the emergency vehicle specific EV market overall. Very few aftermarket offerings are available that are specific to these vehicle types.

It is recommended that agencies meet with their local manufacturers' representatives and select an upfitter before making vehicle purchases to fully understand potential pitfalls. This includes all electric, hybrid and any other non-traditional platform being considered.

Lead times for equipment and vehicles:

All lead times for vehicle builds should be considered before any vehicle or equipment purchases. Lead times for upfitters, OEM's and the aftermarket vehicle manufacturers can be long. The best suggestion is to do the research up front and know what you are getting into before making the decision to deviate from the traditional or more normal vehicle purchase scenarios.

Current lead times for light duty vehicles: 4-12 months
Current lead times in California for vehicle upfitting once equipment has arrived: 4-6 months
Current lead time for large apparatus: 3-5 years

Each of the above lead times are estimations based on current experiences. These times might be shorter based on many factors, examples being current contracts, upfitters that are making exceptions to get vehicles in sooner etc.

Environmental Impacts

Emissions Reduction:

Assess the environmental benefits of reducing carbon emissions and noise pollution in urban areas.

- Establish Baseline Emissions
- Analyze Electric Fire Truck Emissions
- Calculate Emissions Reductions
- Evaluate Lifetime Emissions

- Assess Additional Environmental Benefits
- Consider Operational Efficiency
- Quantify and Report
- Monitor and Adjust

Sustainability:

Consider the long-term environmental impact and alignment with departmental sustainability goals.

- Define Sustainability Goals
- Conduct a Lifecycle Assessment
- Evaluate Emissions Reductions
- Assess Energy Use and Costs
- Examine Air Quality and Noise Benefits
- Consider Technological Advancements
- Evaluate Environmental Policies and Compliance
- Engage Stakeholders
- Monitor and Report

Funding and Financing Options:

Grant Opportunities:

Explore available grants and funding options specific to electric vehicle adoption.

Leasing vs. Purchasing:

Evaluate leasing options as an alternative to outright purchase to manage cash flow and budget constraints.

Manufacturer Support and Service Network:

Vendor Reputation:

Research the manufacturer's track record with electric vehicles and their support network.

Service Availability:

Ensure access to maintenance and repair services, including availability of spare parts.

Community and Stakeholder Engagement:

Public Perception:

Consider community expectations and perceptions regarding the adoption of electric fire apparatus.

Stakeholder Consultation:

Engage with stakeholders such as city officials, residents, and other emergency services to gather feedback and support.

Long-term Strategic Planning:

Future Technology Trends:

Anticipate advancements in electric vehicle technology and infrastructure that may impact future fleet management.

Scalability:

Plan for potential expansion of electric vehicle adoption within the department's overall fleet strategy.

Conclusion

In conclusion, while electric fire apparatus represents a significant advancement in firefighting technology, offering benefits such as potential reduced emissions, lower operational costs, and enhanced safety features, it also presents several challenges that must be addressed. The initial high costs, potential reliability concerns, and the need for substantial infrastructure investments are important considerations that could impact the widespread adoption of electric fire trucks. As the technology continues to evolve and improve, it is crucial for stakeholders to weigh these pros and cons carefully, ensuring that the transition to electric fire apparatus is both economically feasible and operationally effective. Future research and development will play a critical role in overcoming current limitations and optimizing the performance of these innovative firefighting solutions, ultimately contributing to a more sustainable and resilient emergency response system.

It is highly recommended that agencies reach out to their OEM vehicle manufacturer, the selected upfitter('s), and most important, those within your agency who specialize in vehicle and fleet related items. If your agency has an established apparatus committee which reviews and makes fleet decisions, it is important to include all subject matter experts as part of those committees. Examples of this would be your Fire Mechanic and/or Fleet Manager to work as part of the team make the most educated decisions possible. The inclusion of the right people in your apparatus committee teams can reduce liability and increase employee morale by giving your agency the best possible solutions with the least maintenance costs.

In summary, this paper has explored the multifaceted implications of electric fire apparatus in the fire service highlighting both the opportunities and challenges associated with this apparatus. The insights presented are intended to guide stakeholders in making informed decisions and fostering innovative approaches to incorporating EV's into the fire service.

The Northern California Fire Mechanics Association, Southern California Fire Mechanics Association and California Fire Mechanics Academy Inc. can provide resources to all agencies and have representatives available to answer questions and provide feedback, please feel free to use these valuable resources.

- **Northern Section of the California Fire Mechanics Association**
  www.californiafiremechanics.org
- **Southern Section of the California Fire Mechanics Association**
  www.californiafiremechanics.org
- **California Fire Mechanics Academy**
  www.cafiremech.org

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