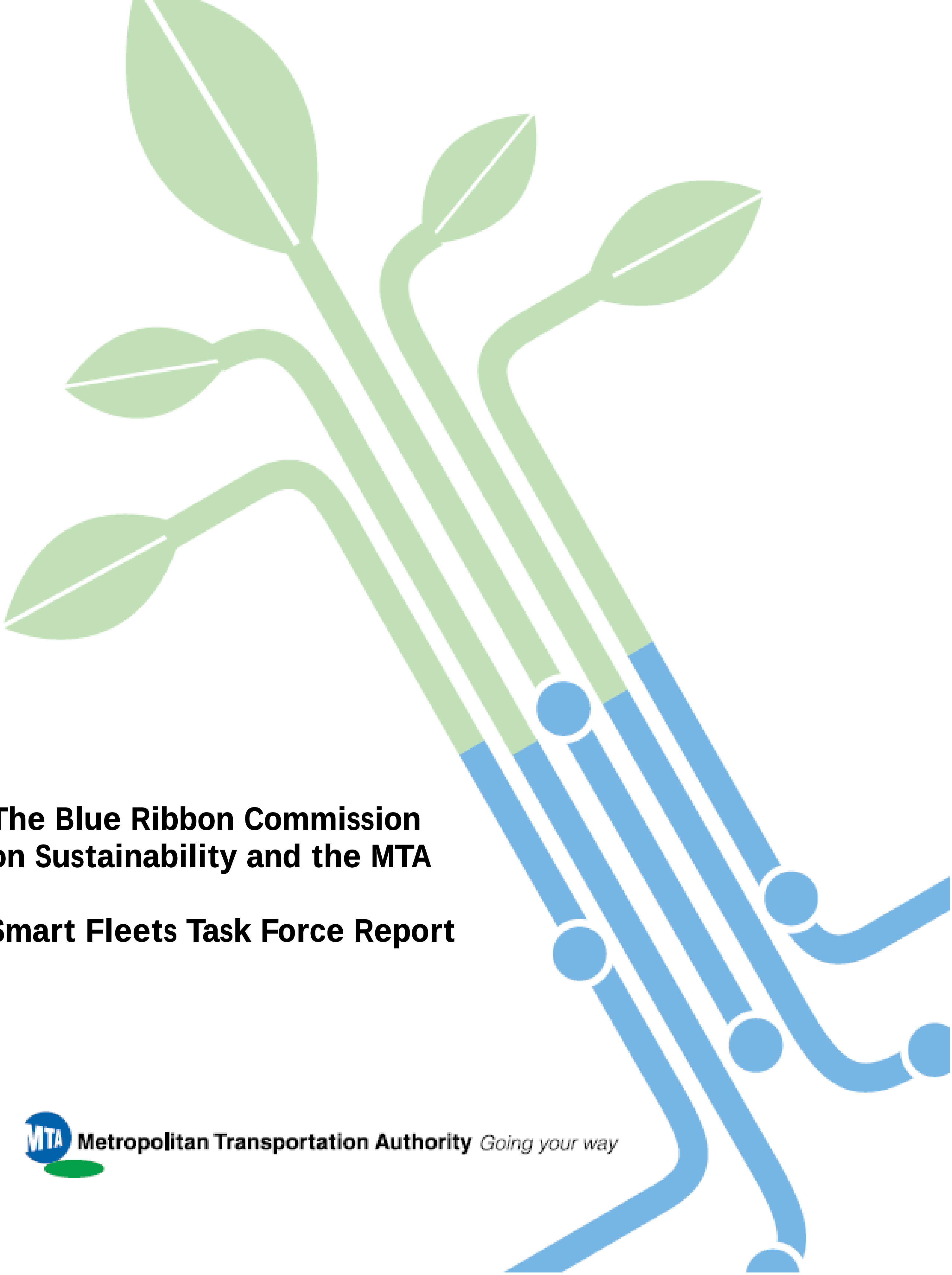

The Blue Ribbon Commission on Sustainability and the MTA

Smart Fleets Task Force Report

Metropolitan Transportation Authority *Going your way*

Smart Fleets Task Force Report

1. Introduction and Background

Traction Power - the energy required to move subway cars, commuter rail-cars and buses – constitutes the largest proportion of the total MTA energy consumption. Any effort to reduce energy consumption at the MTA would not be complete without addressing traction power. With this in mind, the Smart Fleets Task Force (Task Force) was established, under the aegis of the Blue Ribbon Commission on Sustainability and the MTA (Commission). The Commission's efforts are organized under the following heads – Energy/Carbon, Materials Flow, Water, Smart Growth / Transit Oriented Development and Facilities. The Task Force's work may be categorized, jointly, under both Energy/Carbon and Materials Flow.

The Smart Fleets Taskforce was convened to develop and evaluate sustainability strategies for energy consumption within the MTA's subway and commuter rail networks. It is composed of lead rail-car designers from New York City Transit (NYCT), Long Island Rail Road (LIRR) and Metro-North Railroad (MNR). To date, the committee's work has focused on improving efficiency, weight savings, and reducing total energy demand without compromising performance or passenger service. The existing vehicle equipment/systems, vehicles currently being procured, and the requirements for future fleets were all considered with regard for the unique demands, operating and regulatory environment for each agency.

NYCT has taken the lead in analyzing a number of weight savings and energy management concepts. For the purposes of this study, these concepts can be categorized as either feasible on new vehicles or as a retrofit, or concepts with significant promise for future vehicles. This report summarizes the status of NYCT's work in these areas.

2. Summary of Initiatives Implemented to Date and Planned

The committee conducted several industry reviews and technical brainstorming sessions to identify weight savings and energy management concepts that were either relative easy to introduce or achievable both technically and financially using mature technology. Furthermore, industry suppliers, worldwide academia and global transit experts were solicited to provide theoretical ideas and practical suggestions to identify potential initiatives. This approach was taken to help realize a benefit on the various vehicle (rail and bus) procurements that are currently on going within NYCT, with a major focus on rail.

Table 1: Vehicle Weight Reduction Concepts

	Description	Potential to Retrofit
I. Carbody		
	Eliminate unnecessary or excessive structural redundancy	No
	Optimize fabrication using new joining technology Laser welding	No
	Streamline or eliminate composite end bonnets	No
	Side door thresholds design - new materials	Yes
	Investigate alternative materials for between car safety chains / bologna springs and storage box	Yes
	Investigate using lighter composite materials for "hard to reach" ceiling and wall panels	Yes
	Investigate requirements for end wall / "between car" windows to reduce glass thickness	Yes
	Investigate the use of lightweight composite materials for various components (e.g. equipment box covers)	Yes
	Evaluate alternative seat / framing materials	Yes
II. Trucks		
	Eliminate unnecessary or excessive structural redundancy/optimize frame and bolster design	No
	Gear units - utilize suppliers with lowest weight, qualified units	Yes
	Evaluate using one Free Axle on 1 non-motorized truck replacing OSMES as a speed measurement device	Yes
	Investigate reducing weight of coupler guides on type 1 truck for 60' long cars	No
III. Coupler		
	Evaluate tube style link bar with single draft gear	Yes
V. Auxiliary System		
	Wiring - reduce size and optimize routing, evaluate new types and material, eliminate discrete for network	No
	Increased use of fiber optics	No
	Investigate using Giga Cell Battery to reduce number of batteries.	Yes
	Reduce Battery box weight/alternative materials	Yes
VII. Air Brake		
	Reduced the number and load on air compressor/Evaluate Oiless Compressor	Yes
	Reduce number of isolation valves, SBCO etc	Yes
	Air piping - reduce size and optimize routing and evaluate new types and material	No
VIII. Door & Door Controls		
	Evaluate alternative door operators	Yes
IX. HVAC		
	HVAC glass wool instead of metal air duct	Yes
	HVAC small diameter evaporator coil	No
XI. Lighting		
	High efficiency lighting and ballasts	Yes
	Alternative materials for lighting housing	Yes
XII. General		
	Fasteners and equipment mounting optimization - such as tapping pads and shims	No

2.1. Weight Savings Realized on the Current Fleets

NYCT has already begun to realize a reduction in rail vehicle weight through the introduction of lighter weight components or by implementing low impact design changes on some New Millennium Trains (NMT) i.e. R142, R142A, R143, R160. These changes were feasible because the revised design proved to meet current performance requirements or realized savings by eliminating redundant or legacy parts with very low or no usage. On the other hand, it has proven difficult to realize a large weight savings on existing vehicles or existing vehicle designs already under delivery since much of the vehicle is already designed and qualified for service. Regardless, a notable amount of weight savings has already been realized through relatively simple changes (see Table 2). A commercial strategy has also been considered where a money incentive is offered in the procurement contract, instead of a penalty, to foster the development of lower weight designs.

The total potential weight savings realized from the best case scenario outlined in Table 2 is equivalent to approximately 34,692 lbs per 10 car unit train, based on NYCT's estimated annual energy consumption per pound of vehicle weight (3.03). This kWh energy savings potential could result in cost savings of approximately $105,117 per year per new 10 car unit train.

The integration of these weight reduction ideas into NYCT's current SMS and potential retrofitted vehicles would result in a weight savings of 5,743,768 lbs, 17,403,617 kWh or $1,914,400 per year.

While weight savings ultimately result in energy reduction and cost savings, there are also secondary savings through reduced infrastructure wear.

Total Potential Savings - Current SMS / Retrofit		
Weight(lbs.)	Energy / year (kWh)	Savings ($) / Year
5,743,768	17,403,617	$1,914,400

Table 2: Potential Weight, Energy and Cost Savings for Current/Retrofit and Future Fleets

		Total Number of 10 Car Trains		Total Potential Savings SMS / Retrofit			Total Potential Savings New Design		
Description		SMS / Retrofit	New Design	Weight lbs.	Energy / year kWh	Cost / Year	Weight lbs.	Energy / year kWh	Cost / Year
I. Carbody									
	Eliminate unnecessary structural redundancy: secondary center collision posts (2 per A-car)	0	148	-	-	$ -	106,560	322,877	$ 35,500
	Floor pans stamped on R160 (540lbs) vs. fabricated on R143 design (600lbs)	360	186	216,000	654,480	$ 72,000	111,600	338,148	$ 37,200
	Composite instead of plymetal panel flooring	426	172	2,922,360	8,854,751	$ 974,000	1,179,920	3,575,158	$ 393,300
	Advertisement card clips - changed from metal to plastic	0	172	-	-	$ -	17,200	52,116	$ 5,700
	Reduction in heater grill weight	128	186	10,240	31,027	$ 3,400	14,880	45,086	$ 5,000
	Eliminate Flip up seats	184	186	66,240	200,707	$ 22,100	66,960	202,889	$ 22,300
II. Trucks									
	Corrugated Wheels / Lightweight Wheels	0	186	-	-	$ -	1,041,600	3,156,048	$ 347,200
	Gear unit - utilize supplier with lowest weight	0	186	-	-	$ -	297,600	901,728	$ 99,200
	Investigate reducing weight of coupler guides on type 1 truck (one location on A-cars only)	312	186	27,456	83,192	$ 9,200	16,368	49,595	$ 5,500
	Redesign of trip cock linkage - (reduce weight from 53 lbs./truck on R142A/R143 design)	81	186	25,920	78,538	$ 8,600	59,520	180,346	$ 19,800
	One Free Axle on 1 non-motorized truck replacing OSMES (speed measurement)		148	-	-	$ -	1,184,000	3,587,520	$ 394,600
III. Coupler									
	Eliminate 1 of 2 coupler adapters on all NMTs units	0	186	-	-	$ -	81,840	247,975	$ 27,300
	Utilize single draft gear (tube style) link bar (used at B-Car link bar interfaces only)	312	186	816,192	2,473,062	$ 272,000	486,576	1,474,325	$ 162,200

IV. Train and Car Controls									
	Eliminate OSMES, brackets and equipment	312	38	224,640	680,659	$ 74,900	27,360	82,901	$ 9,100
V. Auxiliary System									
	Investigate using Giga Cell Battery with alternative battery box	0	148	-	-	$ -	539,904	1,635,909	$ 180,000
VII. Air Brake									
	Reduce number and load on air compressor - Utilize Oiless Compressor concepts	488	186	1,434,720	4,347,202	$ 478,200	546,840	1,656,925	$ 182,300
		Total Saving per Year =		5,743,768	17,403,617	1,914,400	5,778,728	17,509,546	1,926,200
		Total Savings over 20 years = (assumes implementation at approx. mid-life)			**348,072,341**	**$ 38,288,000**	**Total Savings over 40 years =**	**700,381,834**	**$ 77,048,000**

2.2. Weight Saving on Future Fleets (R179 / R188)

The opportunity for significant weight savings exists primarily on future NYCT fleets because:

- The design process can include lighter weight equipment and structures without excessive (design) costs compared to an existing car.
- A variety of weight savings strategies can be applied simultaneously from the start of the design process.
- The design of interrelated components, such as carbody and trucks or wiring and connectors, can both be modified together to optimize the design.

NYCT continues to consider a number of concepts that show potential for weight savings while still meeting the required performance levels. These concepts are in their infancy and require additional research and study before any decision can be made as to their implementation. A realistic evaluation of the potential weight savings along with life cycle cost (energy and carbon) is therefore needed. The integration of the weight reduction ideas realized from the best case scenario outlined in Table 2 for NYCT's future fleets would result in a weight savings of 5,743,768 lbs, 17,403,617 kWh or $1,926,200 per year.

Total Potential Savings - New Design		
Weight(lbs.)	Energy / year (kWh)	Savings ($) / Year
5,778,728	17,509,546	$1,926,200

NYCT anticipates that a number of these concepts could be incorporated on future procurements. Once a concept is evaluated, justified and finalized, the appropriate vehicle specifications would be updated to reflect the pertinent requirements. For future vehicle procurements, the use of monetary incentives for weight savings, instead of liquidated damages for overweight vehicles, will be considered. This approach is intended to foster the collaboration and innovation between suppliers, car builders and NYCT.

Together, the weight reduction on the current SMS/retrofit fleets and the future fleets at NYCT has the potential to save over 1 Billion Kwh and $ 115 Million over the life of these fleets.

	Energy (Kwh)	**Savings (USD)**
SMS / Retrofit	348,072,341	$ 38,288,000
New Design	700,381,834	$ 77,048,000
Potential Total Savings over 40 years	**1,048,454,174**	**$ 115,336,000**

2.3. Energy Management on the Current Fleet

NYCT's single largest use energy is for vehicle traction power (propulsion) systems. Accordingly, NYCT is focused on strategies to optimize and reduce traction power demand. Perhaps the largest savings of all in this area is obtained through regenerative braking, where by as much as 25% of the traction energy drawn from the power system (the third rail in the case of NYCT) can be returned, under the right conditions. Through the Regeneration Energy Improvement Project, NYCT has studied how to maximize the benefit from regeneration. Actions taken to date from this study include increasing the third rail voltage to improve regeneration capacity from 690 to 720 volts and updating vehicle level software to ensure proper performance during regeneration.

2.4. Energy Management Concepts on Future Fleets

Energy management concepts exhibiting promise for future vehicles are plentiful. Some of these energy management concepts include further optimizing regenerative braking systems, energy storage strategies, optimized auxiliary systems (HVAC, lighting, redundancy), energy efficient train operations (CBCT Train Control) and transmission savings related to Aluminum Third rail.

These concepts include new technologies and operating scenarios that can not be adopted until they are fully evaluated. As with the weight savings concepts, the successful integration of certain energy management technology is best achieved on newly designed (future) vehicles. For example, energy storage devices require the integration of power supply wiring, the integration of monitoring and diagnostic devices, and physical mounting within a vehicle to achieve weight and balance. Typically life cycle costs dictate that this is most efficiently achieved on newly designed vehicles.

Perhaps the largest savings of all in this area is obtained through regenerative braking, where by as much as 25% of the traction energy drawn from the power system (the third rail in the case of NYCT) can be returned, under the right conditions. A research report on Traction Energy -being undertaken by Booz Allen Hamilton- will quantify the potential costs savings related to the implementation of these green initiatives with a greater level of detail and accuracy. Further, this traction energy research report will explore potential scenarios to reduce traction power at the MTA by 10, 25 and 35 percent on a per-passenger mile basis. Based on the findings to date, there remains significant technical and commercial to overcome to realize a savings of 35 percent. The quantification of these potential savings will be reported in the Blue Ribbon Commission on Sustainability and the MTA's Final Report, with the assistance of the Commission research consultant.

2.5. Green Initiative Challenges

The implementation of a Green Initiative strategy includes significant challenges that must be understood, planned for, and managed over the life cycle of the fleet. These challenges include technical and commercial issues that will require support from all levels of the agency. The key challenges, along with potential solutions are summarized in Table 3.

3. Smart Fleet Recommendations

As a result of the analysis of existing rolling stock components and design, the Smart Fleets Task Force identified a number of ways to reduce rail weight and increase energy efficiency. A number of Smart Fleet recommendations have been proposed as a result of the working group process and related Smart Fleet green initiatives (see potential solutions in Table 3).

3.1. Integrate Smart Fleet Green Initiatives

A major initial recommendation of the Smart Fleets Task Force is to continue to integrate and/or implement the Smart Fleet green initiatives -- resulting from the working group -- into the future design, construction, procurement and maintenance of MTA rolling stock. The continued work of the Smart Fleets group should undertake a number of pilot and other prototype testing opportunities to qualify vendors and test green technologies and products for use across multiple fleets / agencies. Adopting this recommendation will result in a significant reduction in Rolling Stock Car Weight thereby reducing the MTA's traction power demand and energy usage.

The Smart Fleet group also recommends that the MTA continue to investigate green initiatives in the future. The Task Force recommends that the MTA expand this initial Smart Fleet group to focus more broadly on retrofitting existing fleets with these green initiatives and investigating green initiatives for other new fleets, including MTA Bus, non-revenue fleets and others.

Table 3. Green Technology Implementation Challenges

Challenges	Potential Solutions	Key Agency Needs to Reach the Solutions
Some risk exists when applying new technology: - Failures due to unforeseen service conditions. - Lack of maintenance support - Lack of spare parts - Rapid obsolescence	• Continued use of loan agreement/ prototype testing on vehicles to qualify vendors • Engage in-house and industry expertise on the evaluation of green technology • Evaluate using certain green technologies across multiple fleets / agencies	• Dedicated funding that targets the evaluation and testing of green technologies. • Create and support green technologies user groups to allow for awareness and ideas exchange
Some green technologies require a sole source procurement	• Re-evaluate and revise current policies regarding sole source buying. • Introduce special riders for green technologies • Evaluate options for negotiating with suppliers	• Executive level support of decisions to procurement via sole source • Policy revisions or establishment of a review board to support green technology procurements
The pricing of some green technologies may not be directly cost competitive with standard equipment	• Utilize total life cycle cost models to evaluate green technologies, include accounting for reductions in green house gases / pollutants	• Policy revisions or establishment of a review board to support green technology procurements

3.2. Revisit Procurement of Innovative Products & Components

Another recommendation resulting from the Smart Fleets Task Force is related to the need to revisit and revise the technical justification and/or procurement process at the MTA in order to facilitate the integration of these and future green initiatives.

For example, the MTA needs to re-evaluate and revise current policies regarding sole source buying as some green technologies require sole-source procurement. In order to combat this potential constraint, the MTA should consider introducing special riders for green technologies and should evaluate alternative options for negotiating with suppliers.

The pricing of some green technologies may not be directly cost competitive with standard equipment. As the traditional cost benefit analysis process is often inadequate for the full analysis of green procurement opportunities, the MTA should investigate alternative procurement analysis, such as life cycle analysis or assessment models, Environmentally Preferable Purchasing, incentivizing sustainable aspects in the procurement process, etc. Along these lines, the Smart Fleet group also recommends that the MTA adopt a policy and set of parameters in order to enable, prioritize and/or expedite the justification for particular green initiatives and technologies, when initial costs are justified in consideration of total lifecycle costs, energy savings and reductions in green house gases / pollutants.

MTA New York City Transit Subway - L Train

4. Conclusion

The goal of the Smart Fleets Task Force was to identify opportunities to reduce rail and subway car weight, increase energy efficiency and reduce carbon emissions, while maintaining safety standards. The Smart Fleets Task Force was successful in identifying a number of relevant green initiatives, resulting in significant potential benefits; In addition to the longer term economic benefits of these the energy savings, significant energy, carbon and other environmental benefits can be realized. The total Smart Fleet green initiatives could result in a considerable reduction in rolling stock weight, significantly reducing the overall MTA energy consumption and resulting in major energy savings and decreased carbon emissions.

New York City Transit
Metro-North Railroad
Long Island Rail Road

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