Conversion of the TCAT Bus Fleet to Electric Mobility

An Exercise in True Sustainability and True Environmental Protection

Vendor Candidate Recommendations for Supply of Electric Bus - Introduction

In June/July 2018 I was invited to the rollouts of the 2019 Jaguar-Land Rover (JLR) hybrid and electric vehicle models at the Irvine Marriott in Irvine, California.

All outstanding products. The highlight of the show, the vehicle that took the center-stage was the all-new full electric Jaguar I-Pace. [A] The author enjoying the JLR gala: [B]

When we say "all new," that is emphasis of the fact that the I-Pace is not a formerly Internal Combustion Engine (ICE) platform, later converted to an electric powertrain. This remarkable vehicle was conceived as an electric vehicle at its Concept stage of development.

This developmental distinction is central to my recommendations regarding which electric bus vendors should be prioritized, as a matter of maximizing the effects of limited research and evaluation resources as deployed, by the Stakeholders (Please see Page 11/12 of cover).

This 'clean-sheet-of-paper' concept-level approach to electric mobility is the development approach that Tata Motors Group adopted for its all-new EVision product; focused on the 'Electrify India' program. C Below, being introduced at the March 2018 Geneva Auto Show by Cornell University alumnus Mr. Ratan Naval Tata, shown at far-left (photo is hyperlink) : D

Mr. Tata is the benefactor of the Cornell Tata Innovations Center in New York; shown at-center with university President Martha Pollack at the December 2017 opening gala: E

The Tata Motors Group owns Jaguar-Land Rover. Unfortunately, relating to this attachment, Tata does not yet manufacture a battery-electric transport bus (BEB). F G H

Vendor Candidate Recommendations for Supply of Electric Bus - Context

Although the cover essay focuses on the TCAT fleet, it would be prudent to mention the other two major bus fleets in the Ithaca, New York area.

There are three major bus transport fleet operators in the Tompkins County, Finger Lakes region, and the immediate Ithaca, New York area:

1. The **Tompkins County Area Transport (TCAT)** public transportation company; an independent organization with both city and rural routes discussed in-detail in cover.

2. The **Ithaca City School District (ICSD**) school bus fleet: This district is comprised of twelve individual schools teaching "K through 12," kindergarten through 12th grade. The ICSD bus fleet covers 77 individual routes for student transport.

3. The **Cornell University Transport (CUT)**: This 'Campus-to-Campus Bus Service' is primarily involved in the daily roundtrip transport between the Ithaca, New York and New York City campuses.

All three fleets overcome region-specific terrain and weather burdens. CUT involves the longest non-stop distance; its route/distance presents the greatest challenge to electric bus range and charging. The CUT route lacks infrastructure with adequate energy levels and/or chargers that accommodate the utility of short recharge times (EXHIBIT A below).

According to the telephone interviews, none of the above have approved/funded plans to update their bus fleets to full EV.

As discussed on cover page 4, review of the Context of these proposals:

A. Proposals that involve (or allege to involve) protection of the environment must ensure that goal comprehensively. Heretofore avoided, the beauty and ecology of the Finger Lakes are not to be diminished in any way, or subjugated to the compromises of **alleged** "sustainability."

B. The attitudes and lack of a **long-term** foresight, of local and state level New York officials, regarding energy plans, specifically as such relates to the incremental power demanded by a **long-term** vision of electric mobility, must be addressed/corrected.

C. Connected to Context B, the world at-large has already determined that transport bus conversion to full EV constitutes the greatest and quickest of comprehensive benefits; the proverbial ***'low hanging fruit.'***

Two vendor candidates have emerged from this exercise that appear, from publically available and telephone interview sources, to fulfill the needs of all three fleet conversions listed above. These recommendations are preliminary.

Vendor Candidate Recommendations for Supply of Electric Bus - PRELIMINARY

If the bus transport circumstances of the Tompkins County region are addressed proactively by a vendor, that candidate will potentially provide ongoing support for this effort; the proactive character of an existing presentation (by a vendor) played a significant part in my thinking.

For example, one vendor has already made available for public viewing numerous videos that address the following key route burden and bus product attributes:

1. Existing and ongoing conversion experience with University clients.
2. Direct experience and interaction with students, that were solicited for original input on the conversion process and subsequent experience/ridership, which provide ongoing feedback and product/infrastructure development.
3. Existing video demonstrations of battery electric bus (BEB) gradeability performance.
4. Video demonstrations of BEB cold weather performance; both on-the-road and HVAC.
5. Existing video demonstrations of BEB performance on snow-covered roads (northeast).
6. Video demonstrations of BEB record breaking range performance on one battery charge.
7. Discussion/video review of their real-world BEB mechanical durability and reliability.
8. Video review of real-world BEB ease-of-serviceability (versus ICE designs)
9. Video discussion of crashworthiness and lack of body corrosion (due to the use of advanced composite materials, not the traditional steel body/frame sheet steel design).
10. Discussion/video review of their real-world contributions to the charging infrastructure.

The most important criteria, mentioned on the first two pages of this attachment, involve the fact that both vendor recommendations have designed their BEB as a full electric at the concept level . . . these BEBs are not converted from the traditional body/frame sheet steel designs, that were originally powered, at *their* concept level with an ICE (i.e. diesel or diesel hybrid).

The two vendors that meet most or all of the above criteria, and are poised to assist with the TCAT, ICSD and CUT bus conversion proposals :

BYD Build Your Dreams®

PROTERRA

BYD is the world's largest BEB manufacturer based in Shenzhen, China with its USA office headquarters in Los Angeles, California. BYD fulfilled most of the 10 criteria listed above.

Proterra is a USA-based manufacturer, which was founded as a concept level BEB maker. Based in Burlingame, California, **Proterra fulfilled all of the 10 criteria listed above.**

Vendor Candidate Recommendations for Supply of Electric Bus - PRELIMINARY **

The only manufacturer that has already delivered a BEB to an American university is Proterra. That gala took place in early 2016 at the University of Montana at Missoula: J

Fulfilling Criteria #1and #2 from page 4 above, the order for the 2 electric buses was placed by the Associated Students of the University of Montana (ASUM), not university administrators.

These screenshots link to the BEB evaluation Criteria #3 (gradeability) and #4 (cold weather) discussed on page 4 above: K

** All screenshots are hyperlinks (Ctrl and left click)

Vendor Candidate Recommendations for Supply of Electric Bus - PRELIMINARY **

The Proterra screenshots link to the BEB evaluation Criteria: #5 (snow covered roads), #6 (range performance) , #7 (mechanical durability and reliability), #8 (ease-of-serviceability), #9 (concept level development and use of advanced corrosion-resistant composite materials) and #10 (contributions to charging infrastructure) as discussed on page 4 above: L M

** All screenshots are hyperlinks (Ctrl and left click)

Vendor Candidate Recommendations for Supply of Electric Bus - PRELIMINARY

Founded in early 1995, based in Shenzhen, China, BYD Company is wholly owned and partially funded by the government of China. With a market capitalization of approximately $15 billion, BYD has made staggering and rapid progress in the area of EV transportation through its subsidiary BYD Auto Company Ltd.

Soon to be the world's largest EV battery manufacturer, BYD is also in the business of solar panels, a vested interest; hence their heightened advertising of that mode as "sustainable."

Their presence in the United States is growing exponentially, and its October 2017 opening of a BEB manufacturing facility in Lancaster, California is the beginning in what is seen as a strategy to dominate the US EV bus segment. N

In addition to its raw financial might, BYD enjoys an indirect tie to Cornell University through the *'Cornel in China'* program; these ties are decades-old and the envy of other universities. O

Similar to the Proterra offerings, the BYD buses are EV concept level developments, and hence are included in this Preliminary candidate recommendations.

Although the publically available technical information implies that BYD can meet the 10 Criteria listed on Page 4 with their BEB products, their video presentations are not on-par with Proterra. The BYD flagship is the K-9 series. P

Vendor Candidate Recommendations for Supply of Electric Bus - CONCLUSION

1. The Proterra and BYD BEB products should be prioritized by the Stakeholders as part of their efforts to convert the TCAT Bus Fleet to Electric Vehicle Mobility. Q

2. Extension of these product evaluations, by the Stakeholders, to the ICSD and Cornell CUT bus fleets is encouraged.

Endnotes to Attachment 10

[A] https://www.youtube.com/watch?v=E3Ngz785hS0

https://www.youtube.com/watch?v=OePK3nANUHY

https://www.youtube.com/watch?v=dsK15k8yVWo

https://chargedevs.com/features/2019-jaguar-i-pace-an-apex-brand-pounces-on-the-electric-crossover-scene/

[B] http://pvsheridan.com/I-Pace_Irvine-Marriott.pdf

[C] http://www.tata.com/

[D] https://www.youtube.com/watch?v=VKncuDvPSJU

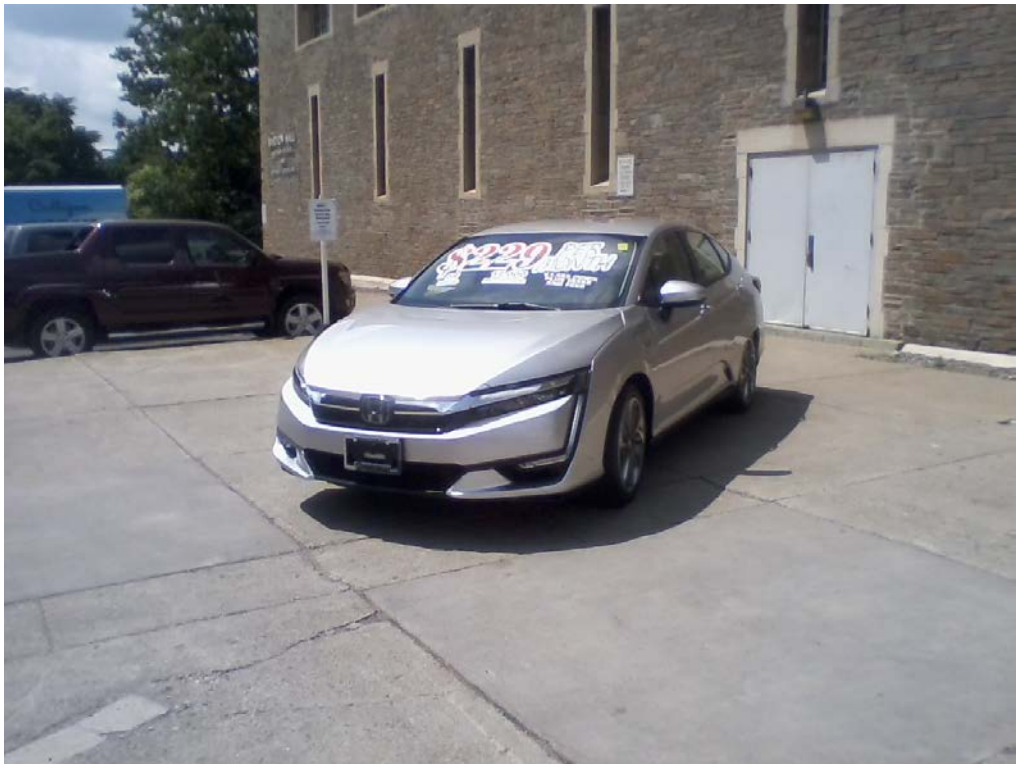
[E] http://news.cornell.edu/stories/2017/12/cornell-tech-celebrates-tata-innovation-centers-launch

http://news.cornell.edu/stories/2017/12/cornell-tech-inaugurates-tata-innovation-center

[F] How Big Is Tata

[G] During 2017/2018 I visited numerous Cornell students, staff, administrators and professors regarding my proposal to showcase the Jaguar I-Pace on our campus. I had and continue to propose that two I-Pace vehicles be made available for display, drive and evaluation. The students "love the idea." The purpose was at least three-fold: (1) continue to inform campus persons whom were/are totally unaware that one of our most generous benefactors is deeply involved in the production of sustainable transportation and, as-such, that Tata Motors Group is the owner of Jaguar, (2) increase exposure of the all-electric Jaguar I-Pace as an exemplar to the Ithaca, New York / Cornell University community, (3) draw attention to the lack of focus, the lack of coursework specific to the electric vehicle paradigm (Review *'Preamble to Proposal - The Stakeholders'* on Page 11 of the cover text).

[H] Relating to the proposal discussed in Endnote G, the showcasing of product from local Ithaca, New York car dealerships is routinely accommodated on the Cornell campus, especially if that vehicle is deemed "sustainable." Please see 'Honda at Cornell,' a typical showcasing outside Barton Hall from April 2018 below:



[I] For example, the concept level design of the Proterra "Duo powertrain" includes an "electrified axle," rather than the retrofit of an electric motor to an existing ICE-based ring-n-pinion differential. The Jaguar I-Pace and the Tata EVision utilize TWO electrified axles in its outstanding design (which allows for extremely competent AWD).

[J] https://www.proterra.com/news-resources/blog/the-sustainability-honor-roll-electric-buses-for-universities-and-colleges/

[K] Video presentations of the ten BEB evaluation Criteria listed on Page 4: in order:

Criteria 1 and 2, University and student involvement: https://www.youtube.com/watch?v=1UI-KWhA-54

Criteria 3, Gradeability: https://www.youtube.com/watch?v=pnrWemnFe_I

https://www.youtube.com/watch?v=V5JV5KRwr54

Criteria 4, Cold Weather: https://www.youtube.com/watch?v=nxxfOdsC4yA

[L] Criteria 5, Snow in the Northeast: https://www.youtube.com/watch?v=8BOK_CwVies

Criteria 6, Extended Range per Charge: https://www.youtube.com/watch?v=slDCwWnpQV0

https://www.youtube.com/watch?v=AEWcVHSoliE

https://www.youtube.com/watch?v=zERKJIeA3F4

Criteria 7, Durability and Reliably: https://www.youtube.com/watch?v=qrwdGFKC-rE

Criteria 8, Ease-of-serviceability: https://www.youtube.com/watch?v=9hrOGjNlAoA

Criteria 9, BEB **Concept Level Development** / Use of Advanced Corrosion Resistant Composite Materials:

https://www.youtube.com/watch?v=4V-D8p3eLuA

https://youtu.be/NIDRYAWn7ds?t=32s

https://youtu.be/9JpMTWdPZ6c?t=3m58s

Criteria 10, Contributions to the Charging Infrastructure:

https://www.youtube.com/watch?v=jw4e02Oje6w
https://www.youtube.com/watch?v=pwdl4HFkyUg
https://www.youtube.com/watch?v=dp3_zUgD6KE
https://www.youtube.com/watch?v=zKM8v0Vdasc
https://www.youtube.com/watch?v=RDwGD_TsMuo

[M] I attended the BMW I-series rollout of 2016 in Irvine, California. I was exposed to the BMW I-3 and I-8 all-electric vehicles, which are also EV concept level developed products. Shortly thereafter, BWM announced its chosen USA-based partner for BEB manufacturing: Proterra. https://www.youtube.com/watch?v=TETNb249DZE

[N] https://www.youtube.com/watch?v=5MN-7VRX-1g

[O] https://global.cornell.edu/cornell-china
https://global.cornell.edu/cornell-china-advisory-board

[P] http://en.byd.com/usa/bus/k9-electric-transit-bus/

[Q] Three Proterra Catalyst zero-emission E2 buses have been delivered to the New York MTA, with five additional BEBs coming as part of the MTA electric bus pilot: https://www.proterra.com/press-release/proterra-secures-three-year-lease-program-with-new-york-mta/ https://www.youtube.com/watch?v=n0GSaKdon0Q
https://www.youtube.com/watch?v=60TDFmH79DU

Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Cornell University Transport - Campus-to-Campus Bus Service

As shown on Page 2 of 3, the following services involve 230 miles/371km, one-way:

Ithaca to NYC Departure Times

	North Campus	Sage Hall	Vet College B Lot
Monday – Friday	5:30 a.m.	5:40 a.m.	6:00 a.m.
3 trips daily	11:30 a.m.	11:40 a.m.	noon
	5:30 p.m	5:40 p.m	6:00 p.m
Saturday	10:00 a.m.	10:10 a.m.	10:30 a.m.
2 trips daily	5:30 p.m.	5:40 p.m.	6:00 p.m.
Sunday	10:00 a.m.	10:10 a.m.	10:30 a.m.
3 trips daily	12:30 p.m.	12:40 p.m.	1:00 p.m.
	5:30 p.m.	5:40 p.m.	6:00 p.m.

NYC Arrival (in order)

- Cornell Club (44th and Madison)
- F Train to Tech Campus (64th and 3rd)
- Weill Cornell Medical College (69th and York)

NYC to Ithaca Departure Times

	Weill Cornell Medical	64th and 3rd	Cornell Club
Monday – Friday	6:00 a.m.	6:15 a.m.	6:30 a.m.
3 trips daily	11:40 a.m.	12:00 p.m.	12:30 p.m.
	5:40 p.m.	6:00 p.m.	6:30 p.m.
Saturday	11:40 a.m.	12:00 p.m.	12:30 p.m.
2 trips daily	4:10 p.m.	4:30 p.m.	5:00 p.m.
Sunday	11:40 a.m.	12:00 p.m.	12:30 p.m.
3 trips daily	4:10 p.m.	4:30 p.m.	5:00 p.m.
	6:10 p.m.	6:30 p.m.	7:00 p.m.

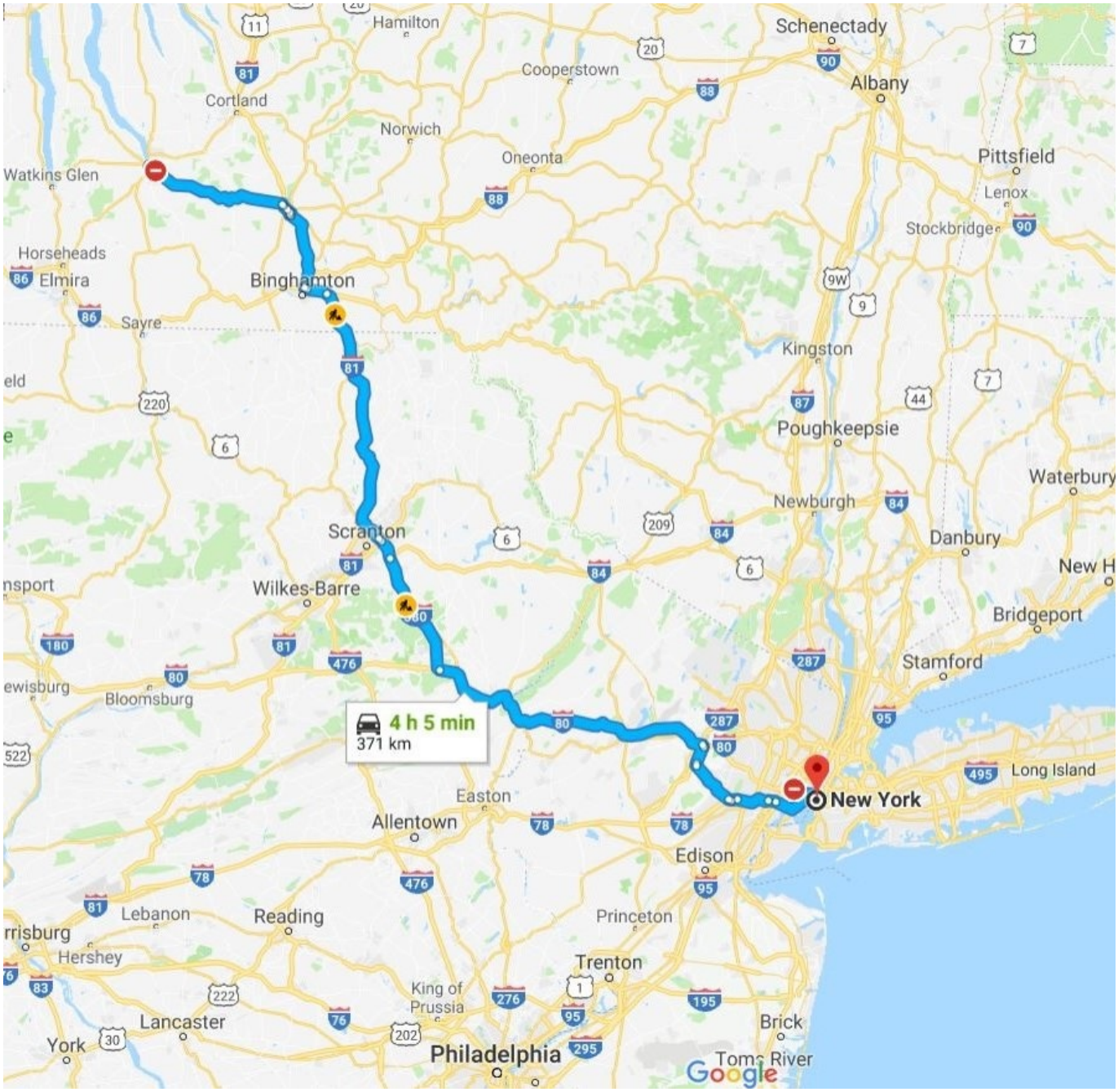
Ithaca Arrivals, in order:

- Vet College B Lot
- Statler/Sage second
- North Campus
- Best Western hotel on demand only, please inform driver prior to Ithaca arrival.

Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Cornell University Transport – Campus-to-Campus Bus Service

The following is meant to depict the approximate distance of the Cornell Transport only, the exact routing(s) are unknown.



Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Cornell University Transport – Campus-to-Campus Bus Service

Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Electric School Bus Roll-outs – New York State

A wonderful subject resource is schoolbusfleet.com . Reported there is the following headline:

"**Lion Delivers 5 Electric School Buses to New York for Pilot."**

The Lion Electric Company, based in Canada, has already delivered 5 *eLion* school buses to the White Plains, New York city school district, for opening day of class September 2018.

Announcing this gala, District Superintendent Dr. Joseph Ricca:

"The White Plains City School District is very excited at the prospect of using electric school buses. With Lion Electric providing five buses to our contractor, National Express, our children will experience the most technologically advanced means of transportation and our community will benefit from the positive environmental impact. We're anxious to roll out the buses in September and continue working to identify innovative and sustainable measures throughout our district."

White Plains seems to have taken the early lead in EV school buses, but they are not alone. Suffolk County and the Islip School District are also actively discussing conversion of their fleet to full EV, with the US-based Blue Bird Bus Company:

Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Electric School Bus Roll-outs – Additional and Often Overlooked Safety Benefit

The Suffolk Transportation Service background wall banner above proclaims that safety is central to their good works**. An issue, that is a subject of long-experience and expertise for the author, is gasoline/diesel-fueled vehicle fires.** Any transportation device that stores large quantities of combustible fluids presents a danger of a consuming and catastrophic fire. **The following occurred two days ago, August 23, 2018, but is not unique:**

The EV school bus greatly diminishes this risk to our children.

Future Electric Mobility Design Exercise/Proposal
Design Review of the Transport Bus Requirements of Tompkins County, New York

Electric School Bus Roll-outs – New York State

Endnotes for Attachment 2

https://www.schoolbusfleet.com/

https://www.schoolbusfleet.com/news/730190/lion-delivers-5-electric-school-buses-to-new-york-for-pilot

https://thelionelectric.com/en

https://www.whiteplainspublicschools.org/page/1

https://www.nationalexpresstransit.com/

https://www.youtube.com/watch?v=-lVPYEzEPpE

https://www.blue-bird.com/electric

http://www.islipufsd.org/our_district/central_administration

http://cornellsun.com/2018/03/23/tcat-bus-catches-fire-on-state-highway-no-injuries-reported/

https://www.youtube.com/watch?v=9bbfPplWYqI

https://www.youtube.com/watch?v=LxdK-ekrabY

https://www.youtube.com/watch?v=TH_0izSyPk0

http://www.kulr8.com/clip/14586156/school-bus-carrying-35-students-suddenly-caught-on-fire

https://www.youtube.com/watch?v=X4QhPYU5uD4