

Hydrogen and Fuel Cell Transit Bus Evaluations

**Joint Evaluation Plan for the U.S.
Department of Energy and the Federal
Transit Administration**

**Appendix A: Summary of Hydrogen and
Fuel Cell Transit Bus Demonstration Sites
in the U.S.**

Technical Report
NREL/TP-560-42781-2
May 2008

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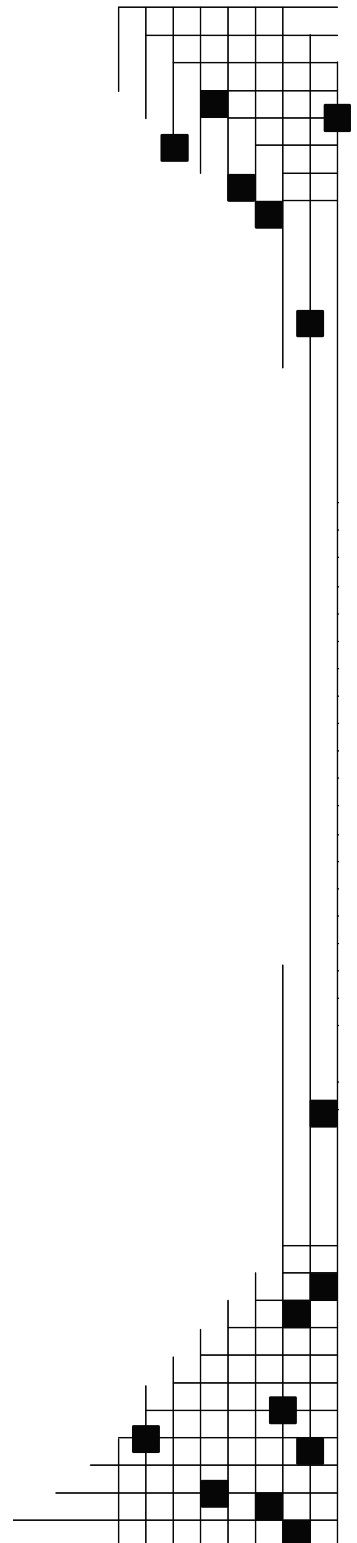
Appendix A: Summary of Hydrogen and Fuel Cell Transit Bus Demonstration Sites in the U.S.

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Contents

Table A1. Summary of Sites and Schedules	1
Table A2. AC Transit: HyRoad	2
Table A3. AC Transit: Accelerated Testing	3
Table A4. AC Transit – Advanced ZEB Demonstration 2009	4
Table A5. SunLine Fuel Cell Bus	5
Table A6. SunLine Fuel Cell Bus – Extended Service	6
Table A7. SunLine HHICE bus.....	7
Table A8. SunLine – All American Fuel Cell Bus.....	8
Table A9. SunLine – Advanced Fuel Cell Bus (Thor rebuild).....	9
Table A10. Connecticut Transit – Fuel Cell Bus	10
Table A11. CT Hybrid Fuel Cell Bus	11
Table A12. Hickam AFB – Fuel Cell Bus & Van	12
Table A13. Dual Variable Output Fuel Cell Hybrid Bus	13
Table A14. Massachusetts Hydrogen Fuel Cell Powered Bus Fleet.....	14
Table A15. Lightweight Fuel Cell Bus Demo – GE/ Niagara.....	15
Table A16. Hydroelectric Hydrogen Powered FCB Demo	16
Table A17. Compound FCB Hybrid Bus for 2010.....	17
Table A18. VTA – Advanced ZEB Demonstration 2009	18
Table A19. New Haven Hydrogen Bus Project.....	19
Table A20. University of Delaware	20
Table A21. University of Texas (Austin)	21
Table A22. City of Burbank Fuel Cell Bus Demo.....	22
Table A23. Ford HICE Shuttle.....	23

Table A2. AC Transit: HyRoad

Project	HyRoad
Lead Organization	AC Transit
Consortia	N/A
Partners	UTC Power: fuel cell system ISE: hybrid system & integration Van Hool: bus chassis Chevron Technology Ventures: infrastructure Golden Gate Transit: demo
Technology description	40-ft hybrid FCB with a 120 kW fuel cell and ZEBRA batteries
Operating Site and location	AC Transit, Oakland, CA
Demo Start Date	March 2006
Duration	2 years
Number of buses	3
Infrastructure description	Natural gas reformer with two dispensers, also fuel light duty FCVs
Evaluation Type	Full
Funding source	DOE



Table A3. AC Transit: Accelerated Testing

Project	Accelerated Fuel Cell Bus Testing
Lead Organization	AC Transit
Consortia	WestStart-CALSTART
Partners	UTC Power: fuel cell system ISE: hybrid system & integration Van Hool: bus chassis Chevron Technology Ventures: infrastructure
Technology description	Accelerated testing to failure of current generation buses
Operating Site and location	AC Transit, Oakland, CA
Estimated Demo Start Date	November 2007
Duration	15 months
Number of buses	3
Infrastructure description	Natural gas reformer and two dispensers
Evaluation Type	Full
Funding source	FTA



Table A4. AC Transit – Advanced ZEB Demonstration 2009

Project	AC Transit CA ZEB 2009
Lead Organization	AC Transit
Consortia	N/A
Partners	UTC Power: fuel cell system Van Hool: bus chassis and hybrid system Chevron Technology Ventures: infrastructure Golden Gate Transit: demo
Technology description	40-ft hybrid FCB with newest fuel cell system and advanced batteries
Operating Site and location	AC Transit, Oakland, CA
Estimated Demo Start Date	2009
Duration	2 years
Number of buses	8
Infrastructure description	Natural gas reformer with two dispensers, also fuel light duty FCVs
Evaluation Type	Full
Funding source	DOE (planned)

Table A5. SunLine Fuel Cell Bus

Project	SunLine Fuel Cell Bus
Lead Organization	SunLine
Consortia	N/A
Partners	UTC Power: fuel cell system ISE: hybrid system & integration Van Hool: FC bus chassis HyRadix: infrastructure
Technology description	FCB: 40-ft hybrid with a 120 kW fuel cell and ZEBRA batteries
Operating Site and location	SunLine, Thousand Palms, CA
Demo Start Date	January 2006
Duration	2 years
Number of buses	1
Infrastructure description	Natural gas reformer, station open to public and also fueling light-duty FCVs
Evaluation Type	Full
Funding source	DOE

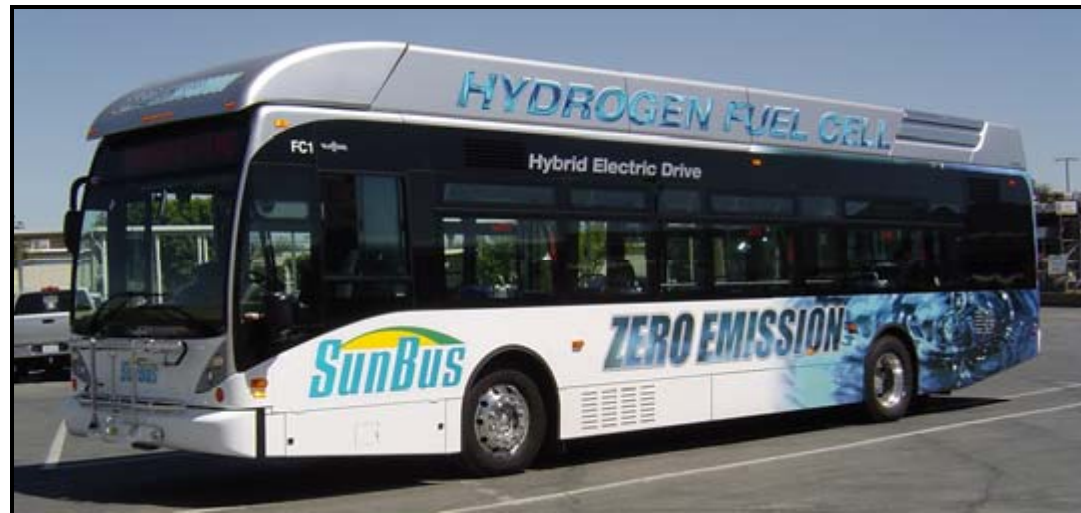


Table A6. SunLine Fuel Cell Bus – Extended Service

Project	Fuel Cell Bus Extended Service
Lead Organization	SunLine
Consortia	N/A
Partners	UTC Power: fuel cell system ISE: hybrid system & integration Van Hool: FC bus chassis HyRadix: infrastructure
Technology description	FCB: 40-ft hybrid with an updated 120 kW fuel cell and ZEBRA batteries
Operating Site and location	SunLine, Thousand Palms, CA
Estimated Demo Start Date	April 2008
Duration	1 year
Number of buses	1
Infrastructure description	Natural gas reformer, station open to public and also fueling light-duty FCVs
Evaluation Type	Full
Funding source	DOE



Table A7. SunLine HHICE bus

Project	HHICE Bus
Lead Organization	SunLine
Consortia	N/A
Partners	ISE: hybrid system & integration Ford: Hydrogen ICE engine New Flyer: HHICE bus chassis HyRadix: infrastructure
Technology description	HHICE: 40-ft hybrid using a Ford V10 engine modified to operate on hydrogen and ultracaps
Operating Site and location	SunLine, Thousand Palms, CA
Demo Start Date	January 2006
Duration	2 years
Number of buses	1
Infrastructure description	Natural gas reformer, station open to public and also fueling light-duty FCVs
Evaluation Type	Full
Funding source	DOE



Table A8. SunLine – All American Fuel Cell Bus

Project	All American Fuel Cell Bus
Lead Organization	SunLine
Consortia	WestStart-CALSTART
Partners	ISE: hybrid system & integration UTC Power: fuel cell New Flyer: bus chassis modified to be more efficient
Technology description	Demonstrate 40-ft FCB with design improvements in an American-made bus chassis; improvements include: newest fuel cell design, lithium-ion batteries, reduced weight to hybrid system, various changes to overall bus to reduce weight and increase efficiency
Operating Site and location	SunLine, Thousand Palms, CA
Estimated Demo Start Date	Late 2008
Duration	15 months
Number of buses	1
Infrastructure description	Natural gas reformer (existing)
Evaluation Type	Full
Funding source	FTA

Table A9. SunLine – Advanced Fuel Cell Bus (Thor rebuild)

Project	Advanced Hybrid Fuel Cell Bus Project
Lead Organization	SunLine
Consortia	N/A
Partners	Ballard: fuel cell ISE: hybrid system and integration Thor: bus chassis
Technology description	An upgrade of the 30-ft Thor FCB to include the latest Ballard FC as well as advanced batteries and hybrid system
Operating Site and location	SunLine, Thousand Palms, CA
Estimated Demo Start Date	November 2008
Duration	1 year
Number of buses	1
Infrastructure description	Natural gas reformer (existing)
Evaluation Type	Partial
Funding source	DOE



Table A10. Connecticut Transit – Fuel Cell Bus

Project	CTTRANSIT Fuel Cell Bus Demo
Lead Organization	CTTRANSIT
Consortia	N/A
Partners	UTC Power: fuel cell system ISE: hybrid system & integration Van Hool: bus chassis
Technology description	40-ft hybrid FCB with a 120 kW fuel cell and ZEBRA batteries (same as ACT and SunLine buses)
Operating Site and location	CTTRANSIT, Hartford, CT
Demo Start Date	May 2007
Duration	2 years
Number of buses	1
Infrastructure description	Liquid hydrogen delivery, storage, and dispensing – station located at UTC Power HQ; renewable H2 production from Niagara falls
Evaluation Type	Full
Funding source	DOE



Table A11. CT Hybrid Fuel Cell Bus

Project	CT Hybrid Fuel Cell Bus Demo
Lead Organization	UTC Power
Consortia	NAVC
Partners	UTC Power: fuel cell
Technology description	Advanced version of the current 40-ft hybrid FCB incorporating the latest technology to increase durability, reliability, and performance of the bus.
Operating Site and location	CTTRANSIT, Hartford, CT
Estimated Demo Start Date	1 st qtr 2009 (1 st bus delivery: 4 th qtr 2008, last bus: 2 nd qtr 2009)
Duration	2 years
Number of buses	4 (3 at site and one floating; could test at up to 4 total sites)
Infrastructure description	UTC Power fueling facility, potential to add fueling at the bus depot
Evaluation Type	Full
Funding source	FTA

Table A12. Hickam AFB – Fuel Cell Bus & Van

Project	Hickam Fuel Cell Vehicle Demo
Lead Organization	HCATT
Consortia	N/A
Partners	Hydrogenics: fuel cell system Enova: hybrid system & integration El Dorado: bus chassis, Workhorse/Utilimaster: van body HydraFLX: infrastructure
Technology description	35-ft battery dominant, plug-in hybrid FCB; FC dominant van
Operating Site and location	Hickam AFB, Honolulu, HI
Demo Start Date	Jan 2008 (data collection delayed due to FC issues)
Duration	1 year
Number of buses	1 bus, 1 van
Infrastructure description	Deployable station design using two Teledyne Electrolyzers
Evaluation Type	Partial
Funding source	DOE



Table A13. Dual Variable Output Fuel Cell Hybrid Bus

Project	Dual Variable Output Fuel Cell Hybrid Bus
Lead Organization	Innovation Drive
Consortia	CTE
Partners	MES: bus chassis and hybrid system Hydrogenics: fuel cell stacks (2) Altairnano: batteries
Technology description	Battery dominant fuel cell system employing a strategy using two 16kW FC stacks packaged into a single 32kW parallel operating system and lithium titanate batteries
Operating Site and location	1) RTC, Columbia, SC 2) second site TBD 3) CTTRANSIT, Hartford, CT (will replace fuel cells)
Estimated Demo Start Date	3 rd Qtr 2008
Duration	One year at each location for a total of 3 years
Number of buses	1
Infrastructure description	TBD
Evaluation Type	Partial
Funding source	FTA

Table A14. Massachusetts Hydrogen Fuel Cell Powered Bus Fleet

Project	Massachusetts Hydrogen Fuel Cell Powered Bus Fleet
Lead Organization	Nuvera/ISE
Consortia	NAVC
Partners	Nuvera: fuel cell ISE: hybrid system and integration A123Systems: energy storage
Technology description	40-ft bus with an 82kW Nuvera fuel cell integrated into a hybrid system with advanced energy storage
Operating Site and location	Massport: Logan Airport, Boston, MA
Estimated Demo Start Date	Mid-year 2009
Duration	2 years
Number of buses	1
Infrastructure description	Nuvera's PowerTap – natural gas reformer
Evaluation Type	Full
Funding source	FTA

Table A15. Lightweight Fuel Cell Bus Demo – GE/ Niagara

Project	Lightweight Fuel Cell Hybrid Bus
Lead Organization	GE
Consortia	NAVC
Partners	GE hybrid system & integration Ballard: fuel cell
Technology description	Lightweight FCB incorporating a 75kW Ballard fuel cell, ultracaps, and lithium ion batteries
Operating Site and location	Site in NY
Estimated Demo Start Date	1 st Qtr 2009
Duration	2 years
Number of buses	1
Infrastructure description	
Evaluation Type	Full
Funding source	FTA

Table A16. Hydroelectric Hydrogen Powered FCB Demo

Project	Hydroelectric Hydrogen Powered FCB Demo
Lead Organization	New York Power Authority
Consortia	NAVC
Partners	Ballard: fuel cell New Flyer: chassis ISE: hybrid system & integration NYPA: overall lead and fueling stations
Technology description	Demonstrate two 40-ft hybrid FCBs with the latest technology (similar to buses for BC Transit)
Operating Site and location	Site in NY
Estimated Demo Start Date	1 st Qtr 2009
Duration	2 years
Number of buses	2 (one prototype and one pre-commercial)
Infrastructure description	Hydrogen produced from electrolysis at Niagara facility.
Evaluation Type	Full
Funding source	FTA

Table A17. Compound FCB Hybrid Bus for 2010

Project	Compound Fuel Cell Hybrid Bus for 2010
Lead Organization	BAE Systems
Consortia	WestStart-CALSTART
Partners	BAE: hybrid system & integration Orion: bus chassis Hydrogenics: fuel cell APU Lincoln Composites: hydrogen storage
Technology description	40-ft diesel hybrid bus with fuel cell APU to handle auxiliary loads, and advanced energy storage; design includes a 15 – 25 kW fuel cell and integrated starter generator coupled to a diesel engine and energy storage system.
Operating Site and location	SFMTA, San Francisco, CA
Estimated Demo Start Date	1 st Qtr 2010
Duration	8 months
Number of buses	1
Infrastructure description	TBD
Evaluation Type	Full
Funding source	FTA

Table A18. VTA – Advanced ZEB Demonstration 2009

Project	VTA CA ZEB 2009
Lead Organization	VTA
Consortia	N/A
Partners	Manufacturers TBD SamTrans: demo partner
Technology description	TBD
Operating Site and location	VTA, San Jose, CA
Estimated Demo Start Date	1 st Qtr 2009
Duration	2 years
Number of buses	4
Infrastructure description	Air Products liquid H2 delivery, storage, and dispensing
Evaluation Type	Full
Funding source	DOE (planned)

Table A19. New Haven Hydrogen Bus Project

Project	New Haven H2 Bus Demonstration
Lead Organization	New Haven
Consortia	N/A
Partners	
Technology description	One hybrid FCB and a hydrogen ICE bus
Operating Site and location	Greater New Haven Transit District, New Haven, CT
Estimated Demon Start Date	
Duration	
Number of buses	2 (one bus of each type)
Infrastructure description	
Evaluation Type	
Funding source	

Table A20. University of Delaware

Project	University of Delaware FCB development/demo
Lead Organization	UD
Consortia	N/A
Partners	UD: development/demonstration, project lead Ballard: fuel cell Ebus: bus chassis and hybrid system
Technology description	22-ft, Ebus hybrid with the latest design Ballard fuel cell and NiCd batteries, also a plug-in
Operating Site and location	UD Campus, Newark, NJ (Transit service in summer)
Estimated Demon Start Date	Bus delivered in spring 2007
Duration	6 mo. to 1 year
Number of buses	1
Infrastructure description	Air Liquide hydrogen station in Newark, NJ
Evaluation Type	Partial
Funding source	



Table A21. University of Texas (Austin)

Project	University of Texas FCB demonstration
Lead Organization	UT
Consortia	CTE
Partners	UT: development/demonstration, project lead Ballard: fuel cell Ebus: bus chassis and hybrid system
Technology description	22-ft, Ebus hybrid with the latest design Ballard fuel cell and NiCd batteries, also a plug-in
Operating Site and location	UT campus, Austin, TX
Estimated Demon Start Date	Bus delivered in fall 2007
Duration	6 mo – 1 year
Number of buses	1
Infrastructure description	GTI station
Evaluation Type	Partial
Funding source	

Table A22. City of Burbank Fuel Cell Bus Demo

Project	Burbank FCB Demonstration
Lead Organization	City of Burbank
Consortia	N/A
Partners	MES: bus chassis and hybrid system Hydrogenics: fuel cells Altairnano: batteries CARB: funding organization
Technology description	Battery dominant fuel cell system employing a strategy using two 16kW FC stacks packaged into a single 32kW parallel operating system and lithium titanate batteries (This bus is expected to be identical to the MES bus for NFCBP)
Operating Site and location	Burbank, CA
Estimated Demon Start Date	Fall 2008
Duration	1 year
Number of buses	1
Infrastructure description	Burbank station
Evaluation Type	Partial or full
Funding source	

Table A23. Ford HICE Shuttle

Project	Ford HICE demonstration
Lead Organization	Ford
Consortia	N/A
Partners	Ford: manufacturer of bus and engine, and lead organization Working with various organizations to test the buses in multiple U.S. and Canadian locations
Technology description	Ford hydrogen fueled ICE engine in a cut-away shuttle bus body. Not a hybrid, but a lower cost alternative to increase H2 use.
Operating Site and location	Orlando, FL; San Carlos, CA; Las Vegas, NV; Univ of Missouri, plus others
Estimated Demon Start Date	Buses began delivery in 2006
Duration	1 year
Number of buses	30
Infrastructure description	Depends on site
Evaluation Type	Partial
Funding source	

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