

# Discussion of Fuel Cell Bus Technical and Cost Target RFI Submissions



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The subject of the request for information (RFI) issued in May 2011 was to solicit input from stakeholders and the research community on proposed performance, durability, and cost targets for fuel cell transit bus applications

The RFI was issued jointly by the Department of Energy and the Department of Transportation

**Department of Energy** Fuel Cell Technologies Program engages in fuel cell RD&D for a variety of stationary, portable power, and transportation applications

**Department of Transportation** National Fuel Cell Bus Program engages in the advancement of fuel cell electric buses

## **Transit bus applications**

- Promising early to mid-term market for fuel cell technology
- Central fueling facilitates introduction of hydrogen fuel
- Less stringent weight and volume criteria make implementation less challenging
- Quiet and vibration-free operation, elimination of criteria pollutant emissions, and high fuel economy attractive for transit applications.

	Units	Pre-RFI Status (Estimated)	Revised Status
<b>Bus Lifetime</b>	years/hours	TBD	TBD
<b>Power Plant Lifetime</b>	years/hours	NA/8,000	6/10,000
<b>Bus Availability</b>	%	66	70
<b>Fuel Fills</b>	per day	1	1
<b>Bus Cost</b>	\$	2,300,000	2,000,000
<b>Power Plant Cost</b>	\$	TBD	1,000,000 <sup>1</sup>
<b>Road Call Frequency (All/Powerplant)</b>	miles between road calls	1,900/2,400	1,900/2,400
<b>Operation Time</b>	hours per day/days per week	19/7	19/7
<b>Operating Cost</b>	\$/mile	TBD	0.47 <sup>2</sup>
<b>Range</b>	miles	>300	>300
<b>Fuel Economy</b>	miles/gallon of diesel equivalent	--	6.5

<sup>1</sup> Average of reported status numbers.

<sup>2</sup> Includes routine maintenance, but excludes fuel and overhaul.

# Targets

	Units	Pre-RFI Targets (Estimated)	Revised Targets
<b>Bus Lifetime</b>	years/hours	12/36,000	12/50,000 <sup>1</sup>
<b>Power Plant Lifetime</b>	years/hours	6/18,000	6/25,000 <sup>2</sup>
<b>Bus Availability</b>	%	85	90 <sup>3</sup>
<b>Fuel Fills</b>	per day	1 (< 10 min)	1 (< 5 min) <sup>4</sup>
<b>Bus Cost</b>	\$	1,000,000	600,000 <sup>5</sup>
<b>Power Plant Cost</b>	\$	TBD	200,000 <sup>5</sup>
<b>Road Call Frequency (All/Powerplant)</b>	miles between road calls	4,000/10,000	4,000/10,000
<b>Operation Time</b>	hours per day/days per week	20/7	20/7
<b>Operating Cost</b>	\$/mile	1.16	0.38 <sup>6</sup>
<b>Range</b>	miles	300	300
<b>Fuel Economy</b>	miles/gallon of diesel equivalent	--	8

<sup>1</sup> Based on RFI responses, with a typical duty cycle 12 years corresponds to ~50k hours. FTA regulations require 12 years or 500,000 miles for heavy-duty transit buses.

<sup>2</sup> A mid-life rebuild of the power plant is expected with diesel ICE buses, so fuel cell buses could be commercialized with the same requirement.

<sup>3</sup> RFI: 85% availability is typical for diesel buses, up to 95% is said to be achievable by 2020. Set target at 90% as a value that should be achievable and that may provide an advantage over diesel ICEs

<sup>4</sup> 10 min was seen as an upper bound by several respondents. This may be a stretch target.

<sup>5</sup> Cost needed to be competitive with alternatives.

<sup>6</sup> Includes routine maintenance, but excludes fuel and overhaul.

- Predictive lifetime modeling for membrane degradation.
- Materials and component design for high performing, low cost plates and long life, low cost seals.
- Improved integration system and stack components for improved power density
- Hybrid vehicle model development
- System component development, including: Hybrid vehicle model; Filter technologies; Steam jet pump; Low pressure turbo; Membrane humidifiers; and Hydrogen storage
- Batteries, design/cost optimization
- Invest in materials and systems R&D to further advance the durability while lowering cost
- Technology to achieve a fast fill time of 5 minutes is needed to be safe and affordable.
- Additional cooling is needed or the tanks need to be less thermally sensitive
- Simplification of a fuel cell bus design and improvements to powerplant / drive train/ battery systems to reduce the labor and troubleshooting portion of transit agency operating costs and reduce scheduled and unscheduled maintenance labor and part replacement cost.
- Cost of H<sub>2</sub> fuel.

# Thank you

For more information, please contact

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