

VIABILITY OF UREA INFRASTRUCTURE FOR SCR SYSTEMS

**U.S. Environmental Protection Agency
Clean Diesel Engine Implementation Workshop
CHICAGO, ILLINOIS
August 6-7, 2003**

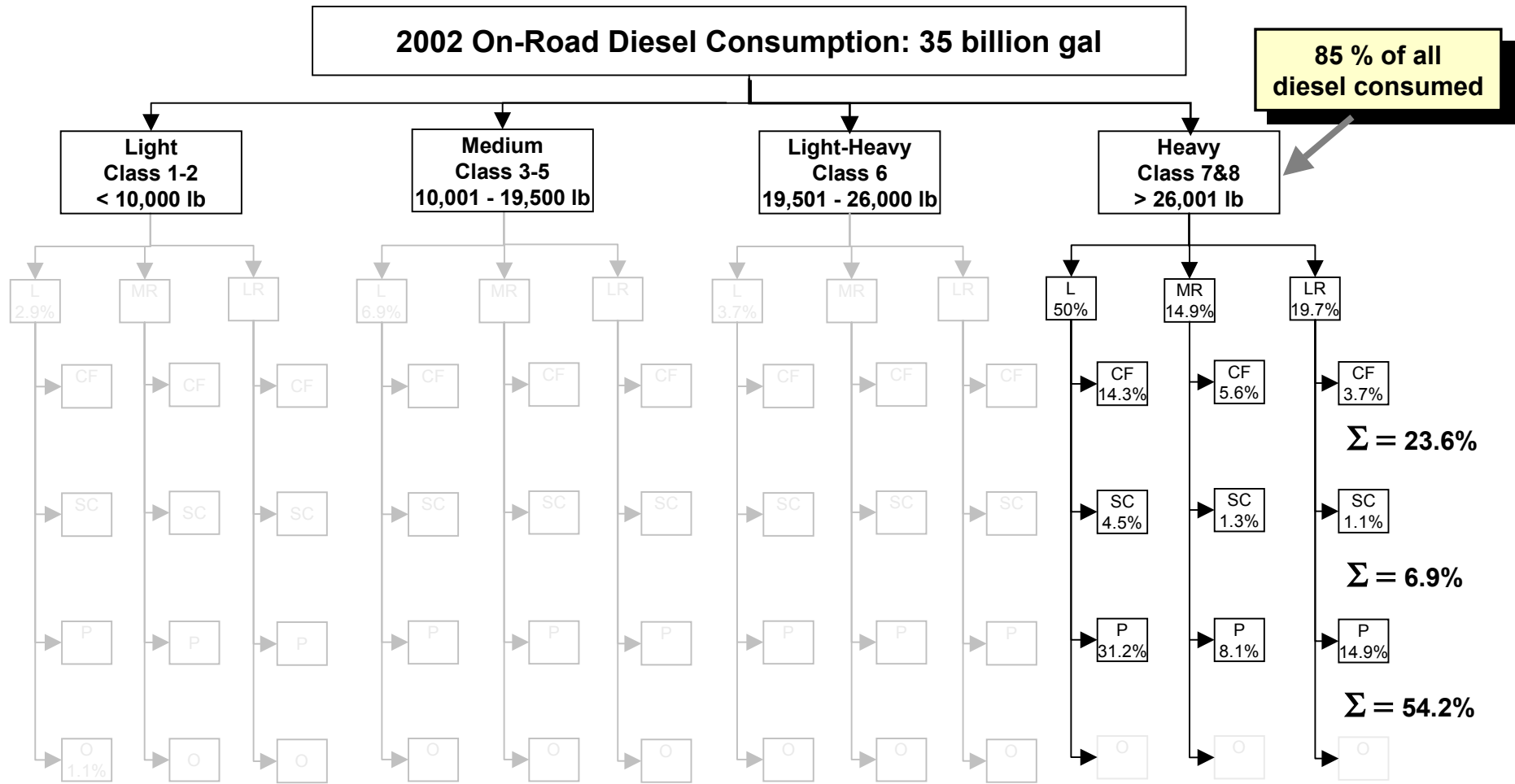


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Urea can be distributed at prices comparable to the price of diesel

- Focus urea distribution to the large public and private diesel retailers serving the Class 7 & 8 trucks sector and consuming nearly 97 percent of the diesel**
- The current world and domestic production capacity of urea is sufficient to cover the increased demand from mobile SCR urea**
- Cost to retail urea is reasonable for the largest retailers and is less than the price of diesel**
- There is a small segment in terms of diesel consumption (3%) that will see urea at prices around \$3/gallon**
- SCR urea is very competitive with NOx adsorber in the early years (2007) and markedly cheaper in later years (2015)**
- For SCR urea to be implemented successfully, all stakeholders must work in a concerted manner**

SCR Urea Implementation Diesel Consumption



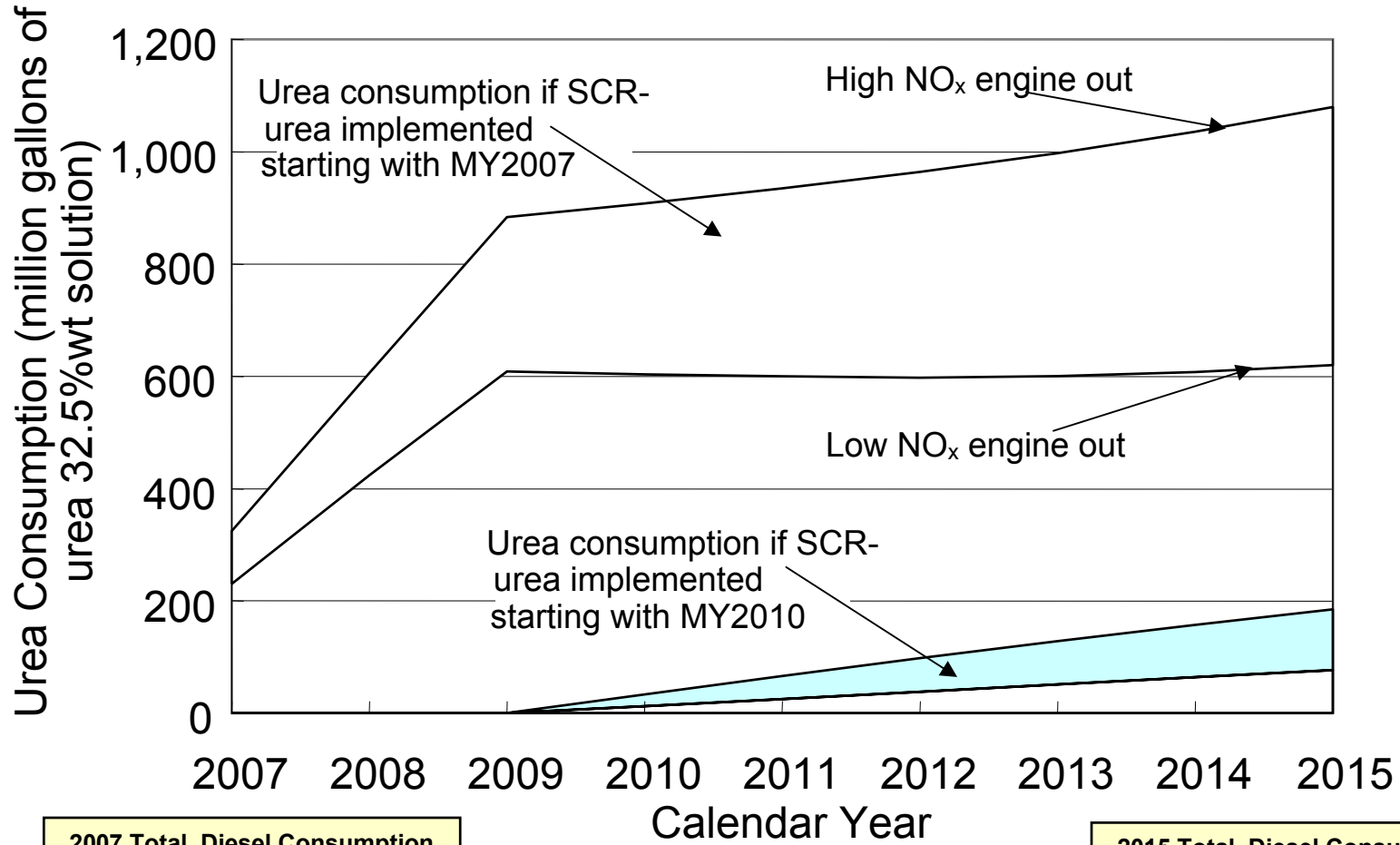
L - Local; < 200 miles
 MR - Medium Range; 200 - 500 miles
 LR - Long Range; > 500 miles
 CF - Central company-owned fueling station; Fleet Stations
 SC - Single contract fueling facility located off site; Cardlocks
 P - Public fueling station; Truck stops and conventional retail stations
 O - Other fueling habit



Profiles of Fueling Stations Serving the Class 7 & 8 Truck Market

Station Size (Monthly Diesel Consumption)	# of Public & Private Stations	Diesel Consumption
Large (2,000,000 — 1,000,000 gal/month)	2,200	77%
Medium (200,000 – 80,000 gal/month)	3,500	20%
Small (<80,000 gal/month)	>25,000	3%

Projected Annual Urea Consumption



2007 Total Diesel Consumption
~43 Billion Gal

2015 Total Diesel Consumption
~57 Billion Gal



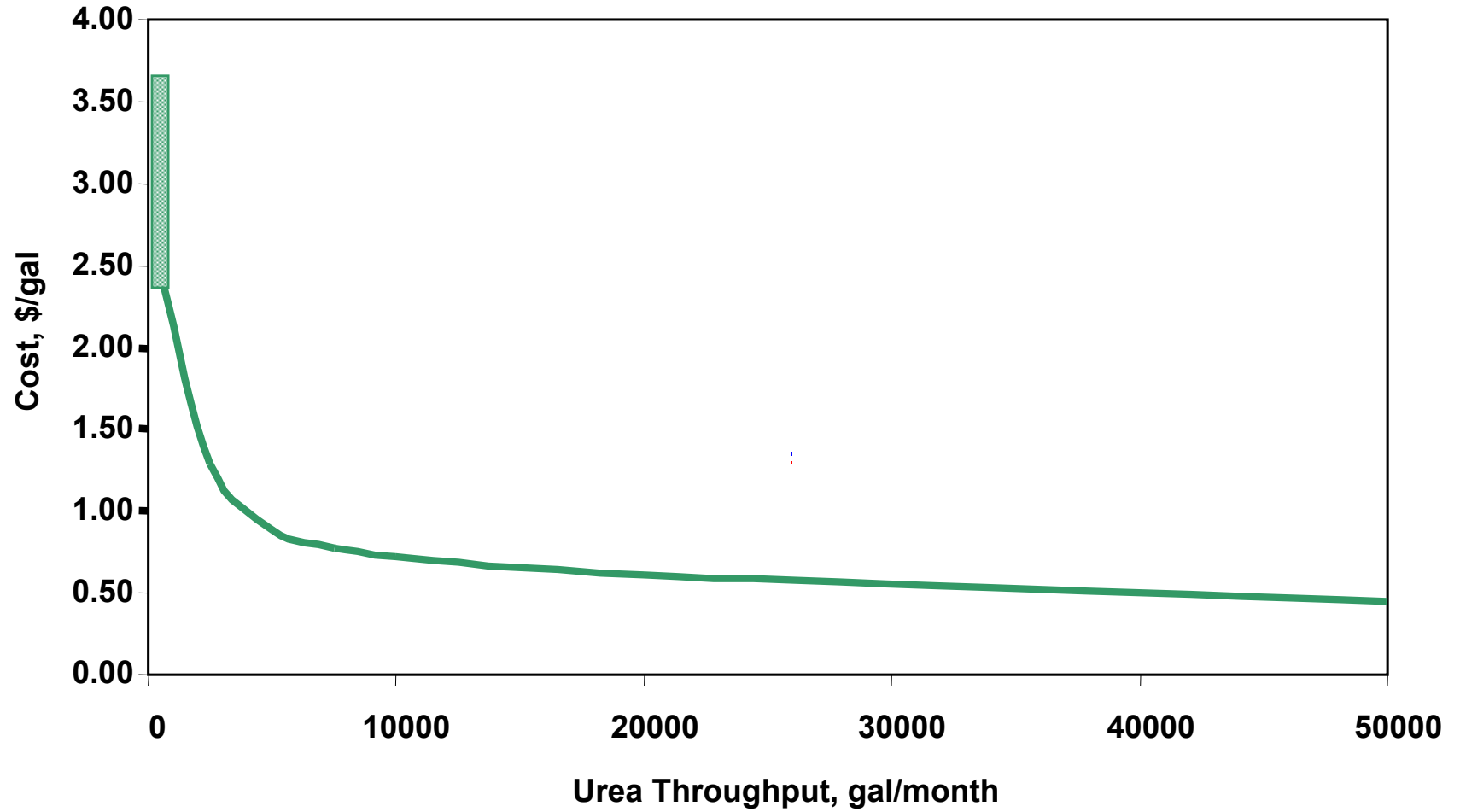
World & Domestic Urea Supply vs. Demand

		MM Tons/Yr
World	Demand	100
	Production	110
	Capacity	133 +
Domestic	Demand	9-10
	Production	6
	Capacity	10 – 17
	SCR Urea Demand*	0.4 – 1.6

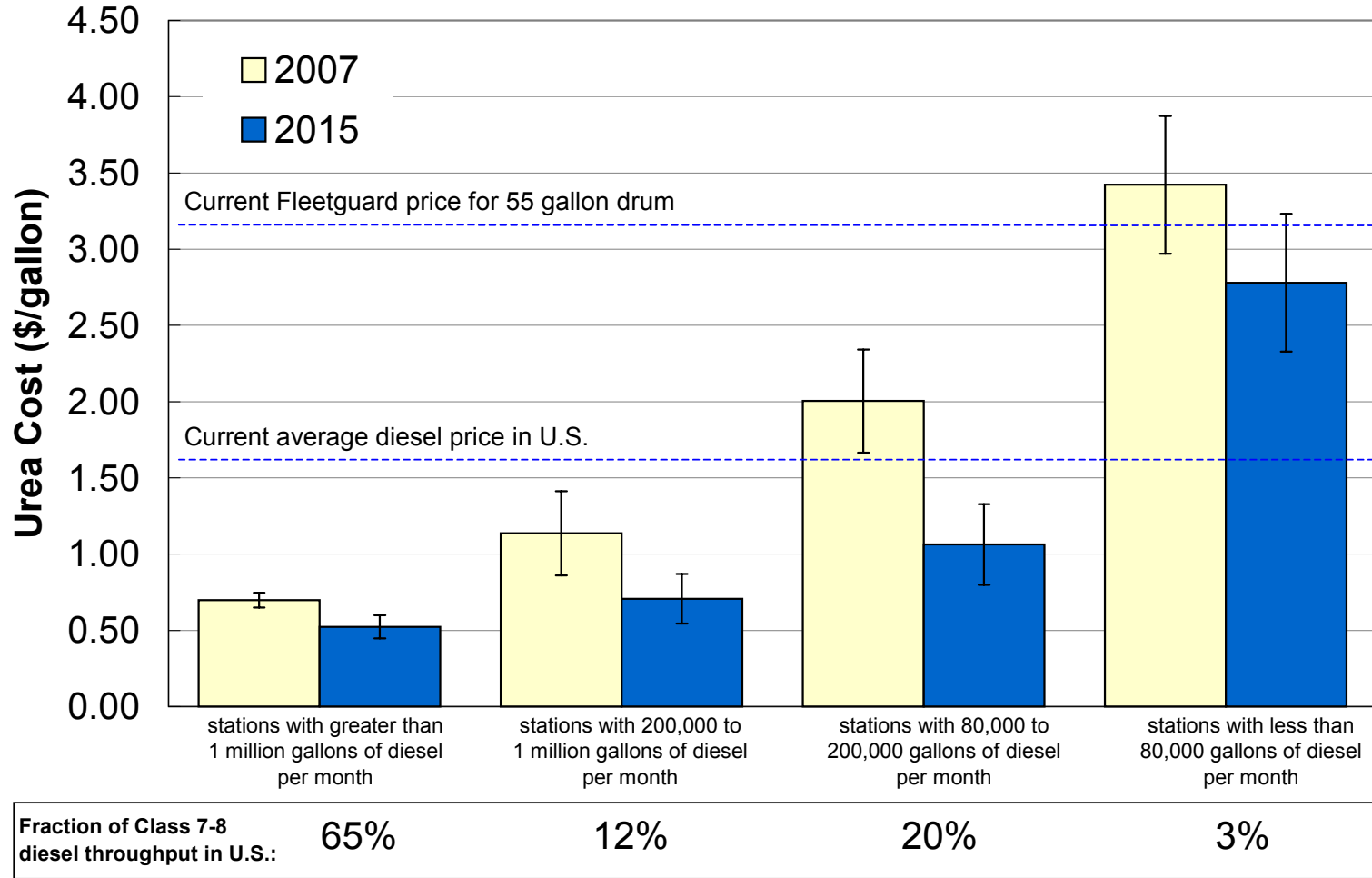
* -- Corresponds to 250 - 1,100 MMgal of 32.2% Aqueous urea
 Domestic demand includes stationary side SCR usage



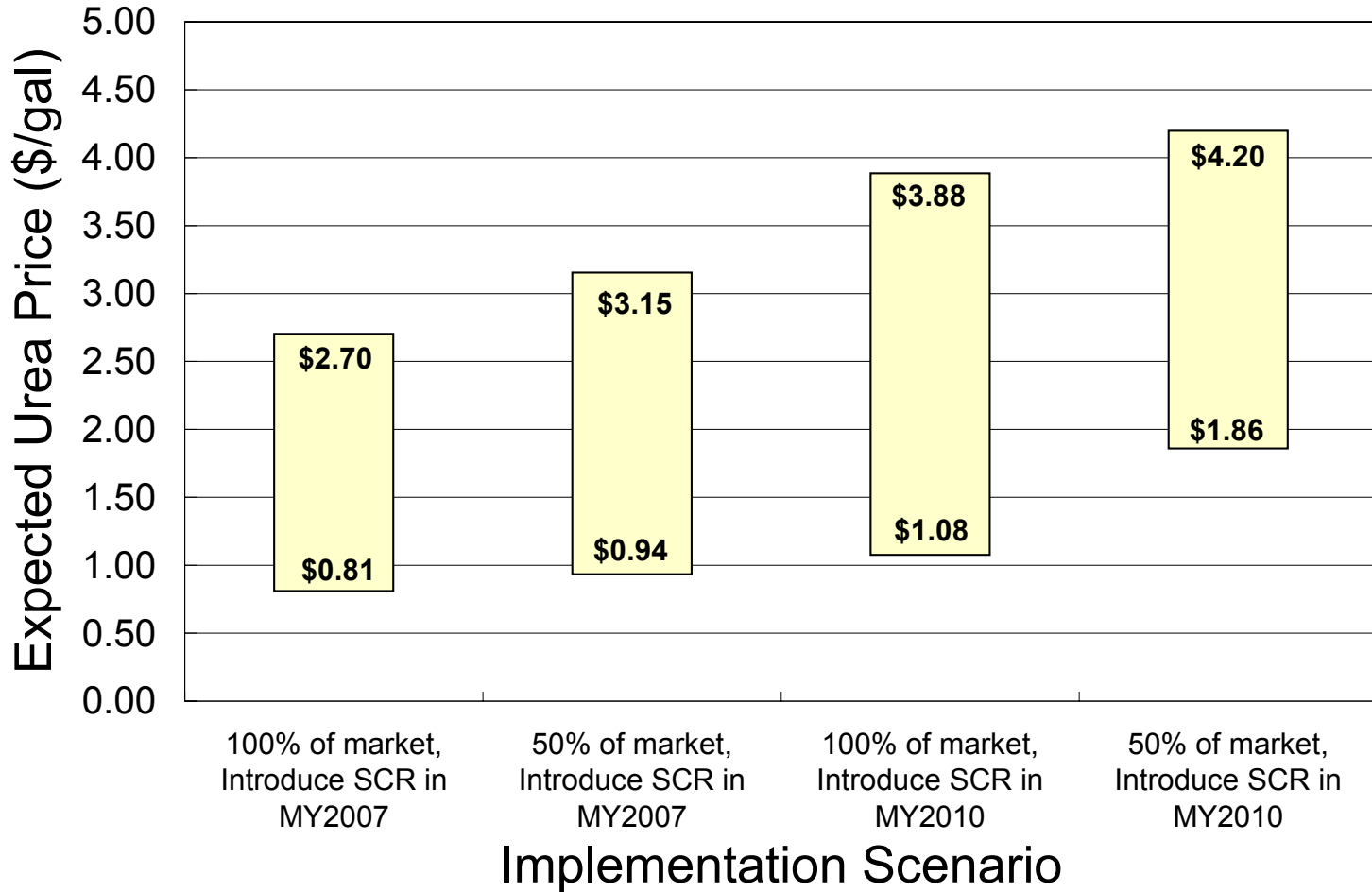
Retail Urea Cost by Diesel Station Throughput



Retail Urea Cost by Diesel Station Throughput



Range of Urea Prices for Various Scenarios



SCR-Urea Implementation Strategies *SCR Urea-NOx Adsorber Break-Even Analysis*

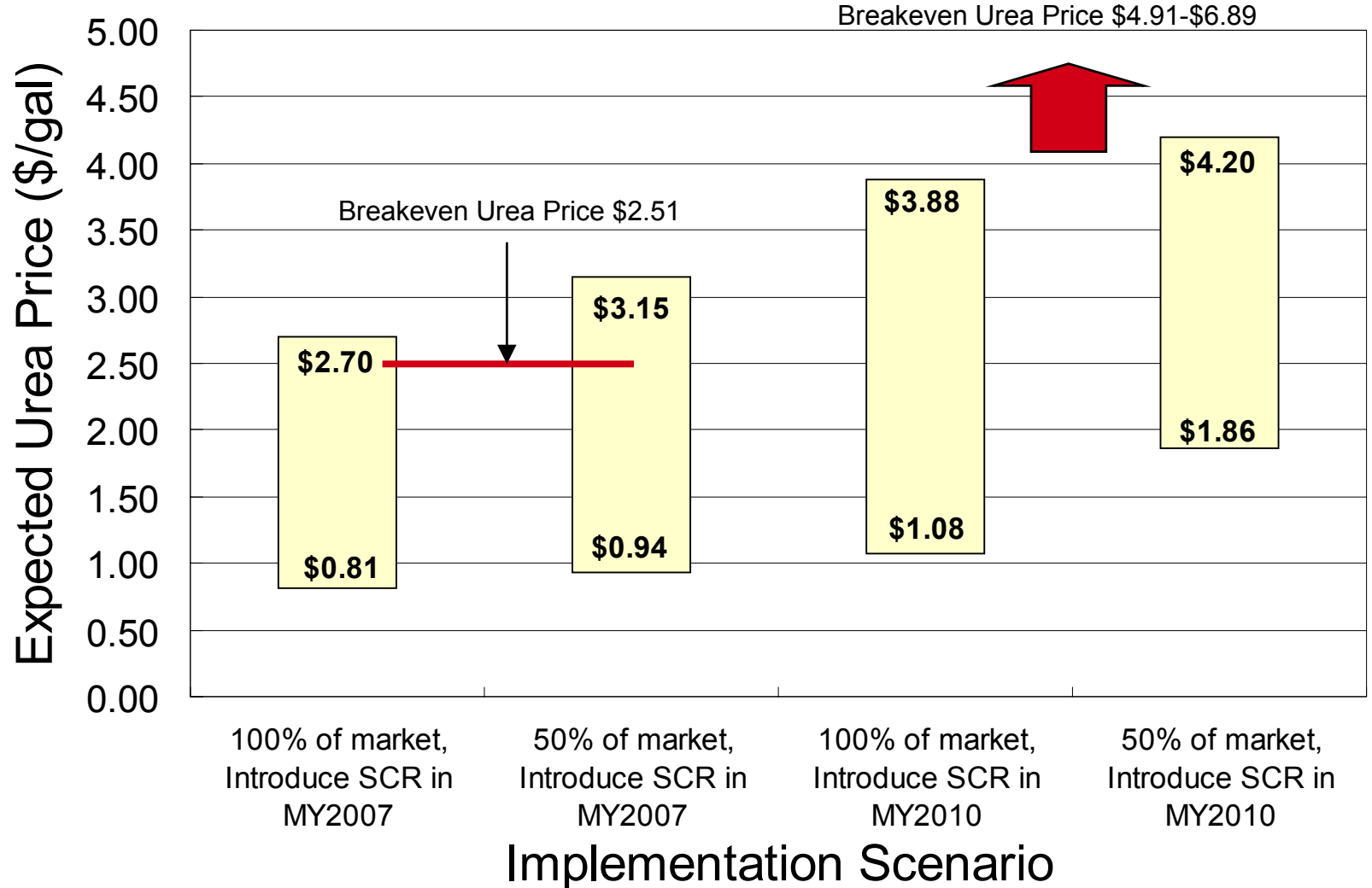
Cost Comparison Parameters for Line-haul Application	2007	2010	2015
NOx Adsorber Fuel Economy Effect	N/A	-5%	-2%
High EGR Fuel Economy Effect	-3%	-3%	-3%
SCR Fuel Economy Effect*	+6%	0%	0%
Installed SCR Cost (relative to alternative emission control system)	\$0	-\$1,000	-\$1,000
Diesel-to-urea Consumption Ratio	18:1	82:1	131:1
Break-even or allowable price of urea	\$2.51/gal	\$6.89/gal	\$4.91/gal
*for MY2007-09 engines, it is assumed manufacturers using SCR will not use high EGR, and can thus produce higher fuel economy engines			

Assumptions:

- \$1.55/gal diesel
- 1 million miles over vehicle life
- High EGR used on alternative systems for MY2007-09 and on all vehicles for MY2010+
- Maintenance costs same for all systems



Breakeven Urea Prices for Various Scenarios



All stakeholders must move in a concerted manner

- **Truck Operators** - key stakeholders since aggregate fueling habits almost evenly distributed between public fueling facilities and private central fueling facilities. Will require installing a urea dispensing facility in their central fleet refueling facilities and need to leverage infrastructure at public facilities. Will require assurance from truck and engine manufacturers on the availability of urea and SCR systems before investing in vehicles or infrastructure.
- **Urea Retailers** - primary retailers of diesel to the Class 7 & 8 truck market. The large truck stops and central fleet fueling facilities are best early adopters. Will require strong signals from customer (truck operators) to carry infrastructure.
- **Urea Distributors** - these are likely to be existing diesel distributors, ag urea distributors and new entrants. Are key to coordinating supply and demand and will require early strong signals from upstream and downstream members in the value chain to make investments.
- **Systems Providers** - vendors of urea distribution, storage, and dispensing equipment. Existing players servicing the petroleum industry are well situated to handle urea. Some niche urea systems developers already exist in Europe.
- **Engine & Truck Manufacturers** - providers of SCR technology. Must initiate strong signals to all downstream members in the value chain on impending this emerging technology.

Thank you for you attention

Acknowledgements

TIAX would like to acknowledge the Engine Manufacturers Association and the National Renewable Energy Labs for making this study possible

Further Published References:

- **“Development of a Urea Infrastructure to Support MY2007+ Heavy-duty Emission Requirements,”** TIAX report to NREL, Contract # ADZ-3-33020-01, May 2003
- **“Selective Catalytic Reduction Urea Infrastructure Study,”** Arthur D. Little report to NREL, Contract No. DE-AC36-99-GO10337

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