DOE Hydrogen Program Record		
Record #: 5030	**Date:** January 30, 2006	
Title: Hydrogen Baseline Cost of $5 per gge in 2003		
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Approved by: JoAnn Milliken	**Date:** February 10, 2006	

Item:

This energy station demonstrated a reduction in the cost of natural gas-based hydrogen production from **$5.00 per gallon gasoline equivalent (gge) in 2003** to $3.60 per gge using innovative reforming and purification technologies.

Supporting Information:

This analysis is based on work first done by Arthur D. Little (now TIAX) and documented in "*Guidance for Transportation technologies: Fuels Choice for Fuel Cell Vehicles", Phase II Final Report to DOE, February 2002*. This report can be found at http://www.tiaxllc.com/industries/pdfs/fuelcells/fc_fuels_report_0206-02.pdf

The analysis included characterizing the capital costs and performance of distributed natural gas reforming technology available at the time. The original analysis was based on a production unit designed for 690 kg of hydrogen/day. It utilized progress ratios to project costs for a market size resulting in the production of 500 units per year. The analysis included the refueling station equipment for compression, storage and dispensing.

In 2003, TIAX modified the original analysis to a design capacity of 1500 kg of hydrogen/day. They used appropriate scaling factors to adjust for the change in equipment sizes. They backed out the progress ratio to obtain capital costs for building a one of a kind unit which was more characteristic of 2003 technology rather than 500 units per year. The following are the results of this modified analysis by TIAX:

Performance Parameters	
Natural gas consumption ((Nm^3/kg of hydrogen)	4.5
Production unit electricity consumption (kWhr/kg of hydrogen)	.56
Production unit energy efficiency	70%
Compression electricity consumption (kWhr/kg of hydrogen)	2.9
Total system energy efficiency	65%

Feedstock and Utility Costs	
Natural gas (LHV basis)	$4.40/MMBTU
Electricity	$.07/kWhr

Capital Costs	
Production unit installed capital cost	$12.3M

Compressor, storage, and dispenser installed capital cost	$1.6M
Replacement Capital	
Annual (% of total depreciable capital/yr)	2%
Other (catalyst replacement)	$1.2M every 5 years

Economic Parameters	
Reference year dollars	2000
After Tax Real Internal Rate of Return	5%
Analysis Period (yrs)	15
Inflation rate	1.9%
Depreciation schedule	MACRS: 7 years
Total tax rate	38.9%
Equity financing	100%
Operating capacity factor	87%

These inputs were used in the H2A Forecourt Production tool spreadsheet in the fall of 2004 and yielded the result of $5.00/gge for the cost of hydrogen. The results are all in 2000 dollars. The full H2A model input for this case is available in DOE Hydrogen Program Record 5030a at http://www.hydrogen.energy.gov/program_records.html.

It should be noted that these economic parameters differ from those currently used in the standard H2A Forecourt Production analyses. The major differences are that standard H2A Forecourt Production analyses are now expressed in 2005 reference year dollars, with a 10% after tax internal rate of return, an analysis period pf 20 yrs, an operating capacity factor of 70%, a natural gas cost of $5.00/MMBTU (LHV basis), and assume 500 units are built per year to represent significant production volumes when hydrogen fuel cell vehicles have significant market penetration. The H2A standard economic parameters were developed after the original TIAX effort with additional insight from stakeholders. The updated H2A Production Tool can be found at http://www.hydrogen.energy.gov/h2a_production.html.