

H2A Delivery

Miscellaneous Costs and H2 Losses



Hydrogen Delivery Analysis Meeting
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Presentation Outline

- Direct and Indirect Costs
- Operating and Maintenance Costs
- Labor Costs and Scaling Factor
- Component Hydrogen Losses

H2A Delivery

Direct and Indirect Costs

- Currently posted model includes site preparation, engineering and design, project contingency, one-time licensing fees and permitting
 - Factor of 1.225 above installed capital in forecourt tabs
 - Factor of 1.745 above installed capital in central tabs
- Revisit necessary with experienced Nexant team to determine appropriate values
- OUTCOME: Consistent values and new category (owner's cost)
 - Owner's cost includes due diligence costs, initial spare parts and operator training that owner will incur

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New Direct/Indirect Costs

- As a percentage of installed capital

	<u>Large-Scale</u>		<u>Forecourt</u>	
<u>Item</u>	<u>New</u>	<u>Old</u>	<u>New</u>	<u>Old</u>
Site Prep	4%	12%	5%	6.5%
Engineering and Design	10%	32%	10%	3%
Project Contingency	10%	25%	5%	10%
Licensing ¹	0%	1.5%	0%	0%
Permitting	3%	4%	3%	3%
Owner's Cost	12%	-	-	-
FACTOR	1.39	1.745	1.23	1.225

¹ 1% licensing fee assumed for liquefiers only

Photos courtesy of
Praxair and Air
Products



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Operating and Maintenance Costs

Forecourt

- Reviewed primarily to ensure that proper annual maintenance and repair costs for compressor
 - New value allowed longer compressor lifetime

<u>Item</u>	<u>New</u>	<u>Old</u>	<u>Notes</u>
Insurance	1%	1%	Of total cap. invest.
Property Taxes	0.75%	1%	Of total cap. invest.
Licensing and Permits	0.1%	0.1%	Of total cap. invest.
Operating, Maintenance and Repairs	See note	1.8%	4% of compressor installed cost 1% of storage installed cost \$800/yr/dispenser
Overhead and G&A	20%	20%	Of total unburdened labor cost

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Operating and Maintenance Costs



Photo courtesy of
Air Products

Large Scale

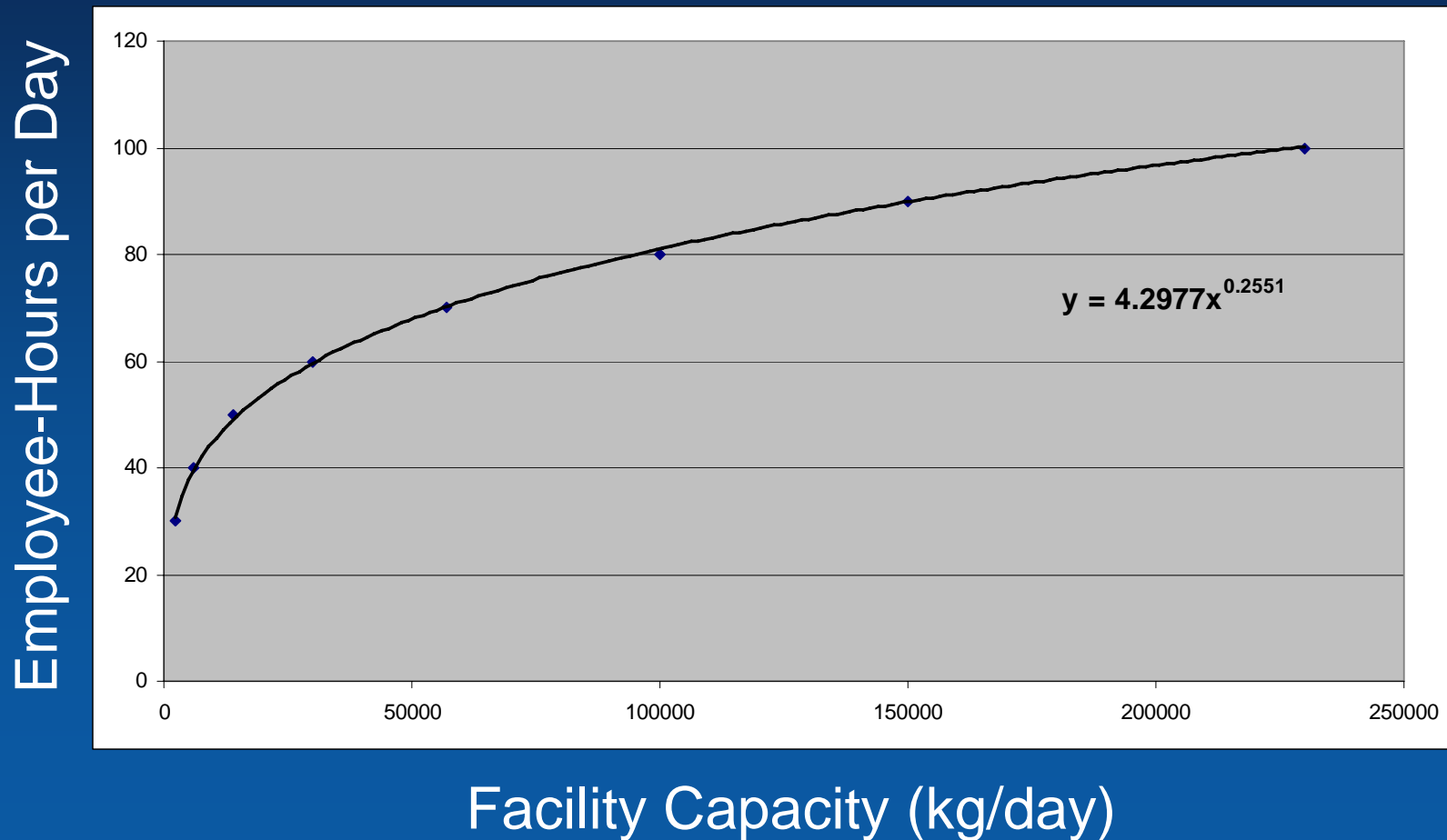
<u>Item</u>	<u>New</u>	<u>Old</u>	<u>Notes</u>
Insurance	1%	1%	Of total cap. invest.
Property Taxes	1.5%	1.5%	Of total cap. invest.
Licensing and Permits	1%	1%	Of total cap. invest.
Operating, Maintenance and Repairs	See note	10%	4% of compressor installed cost 0.5% of other component installed cost
Overhead and G&A	50%	50%	Of total unburdened labor cost

Forecourt Labor Costs

- Labor costs basis (from gas station data):
 - 135,000 gall/month
 - Approximately 1,500 kg/day H2 station
 - 1.5 FTE
 - 33% of FTE time to fueling (remainder to operating snack store)
 - 18 hours/day operation, 365 days/year
 - Total labor hours – 3,250 hours per year
 - Labor cost - \$10/hr, unburdened
- Forecourt labor costs scaled linearly with average station capacity

Labor Scaling

- Based on data from Peters and Timmerhaus at various capacities



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Large-Scale Labor Costs

- Remained fairly unchanged, with exception of scaling factor

<u>Tab</u>	<u>Basis</u>	<u>Wage basis</u>
GH2/LH2 Trailers	Calculated based on the number of trips per year and time per trip	BLS – Heavy duty truck operator with some unloading capabilities (\$20.00/hr)
Compressed Gas H2 Terminal	2 operators, 24 hours per day, and 365 days per year; base capacity is 100,000 kg/day	BLS – Petroleum Plant Operators (\$24.20/hr)
Compressed Gas Storage Tubes	200 hours per year; base capacity is 300,000 kg/day	BLS – Industrial Machinery Repairer (\$19.25/hr)
LH2 Terminal	2 operators, 24 hours per day, and 365 days per year; base capacity is 100,000 kg/day	BLS – Petroleum Plant Operators (\$24.20/hr)
Liquefier	2 operators, 24 hours per day, and 365 days per year; base capacity is 100,000 kg/day	BLS – Petroleum Plant Operators (\$24.20/hr)

<u>Tab</u>	<u>Basis</u>	<u>Wage basis</u>
Bulk Liquid Hydrogen Storage	100 hours per year (approximately 1 day per month); base capacity is 100,000 kg/day	BLS – Industrial Machinery Repairer (\$19.25/hr)
Compressor	260 hours per year (approximately 3 days per month); base capacity is 100,000 kg/day	BLS – Petroleum Plant Operators (\$24.20/hr)
Pipeline	4 FTE's (1FTE = 2,080 hours/year); base capacity is 100,000 kg/day	BLS – General Maintenance and Repairs Person (\$15.05)
Geologic Storage	1 person, 24 hours/day, 365 days/year; base capacity is 100,000 kg/day	BLS – Petroleum Plant Operators (\$24.20/hr)

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Forecourt Losses

- Reviewed losses on each tab
 - RESULT: Inclusion of compressor at LH2 Forecourt to recover unloading/boil-off losses



<u>Tab</u>	<u>New</u>	<u>Old</u>	<u>Notes</u>
<u>GH2 Forecourt Compressor</u>	0.5%	0.5%	Compressor flow
<u>LH2 Forecourt Storage Compressor Unloading</u>	0.25% 0.5% -	0.25% - 6%	Per day Compressor flow LH2 delivered
<u>Forecourt Compressor</u>	0.5%	0.5%	Compressor flow
<u>Forecourt Dispenser</u>	0%	0%	No losses
<u>Forecourt Compressed GH2 Storage</u>	0%	0%	No losses

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Large-Scale Component Losses

<u>Tab</u>	<u>New</u>	<u>Old</u>	<u>Notes</u>
<u>GH2 Tube Trailers</u>	0%	0%	No losses
<u>Compressed GH2 Terminal</u> Compressor(s)	0.5%	0.5%	Compressor flow
<u>Compressed GH2 Storage Tubes</u>	0.0%	0.0%	No losses
<u>LH2 Truck Delivery</u> Unloading	0%	6%	Comp. at LH2 Forecourt
Boil-off	0.5%	0.5%	%/day
Loading	0%	0%	Recycled to liquefier
<u>LH2 Terminal</u> Storage	0.25%	0.25%	%/day
<u>Liquefier</u>	0.5%	0.5%	Liquefier throughput
<u>Compressor (including Geologic)</u>	0.5%	0.5%	Compressor flow
<u>Pipeline</u> Transmission	$1.35 \times 10^{-6}\%$	0.5%	Per mile of trans.flow
Distribution	$0.27 \times 10^{-6}\%$	0.5%	Per mile of distribution flow