

Energy Source Cost Comparisons

Tabular comparisons of the costs of various electric generation technologies presented in Tidal Power Technology by Jack Pare to DES, February 23, 2007

Most of the figures in these tables with no question marks are from an article from Renewable Energy Access titled 'Electric Vision' by Robert Preston Sept 7, 2005 using figures from US Department of Energy, September, 2005.

Figures with question marks are solely the engineering estimates of Jack Pare.

National Comparison Mix of Electric Generation Sources

- Coal 52%
- Nuclear 19%
- Gas & Fuel Oil 18%
- Hydro 7%
- Wood/Biomass, Wind, Solar 4%

from 'Electric Vision' by Robert Preston Sept 7, 2005

using figures from US Department of Energy, September, 2005

<http://www.renewableenergyaccess.com/rea/news/story?id=35854>

National average cost of Electricity

8.83 cents per kilowatt hour

from US Dept of Energy - Electric Power Monthly January 12, 2007

http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

Coal

capital cost	0.72 cent per kilowatt hour
95 % capacity factor	
operating and maintenance	1 cent per kilowatt hour
coal costs	2.14 cents per kilowatt hour
direct costs:	3.14 cents per kilowatt hour
(indirect social costs)	
health costs	5.36 cents
climate	1.07 cents
	total = 10.29 cents per kilowatt hour

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Nuclear

capital cost	0.9 cent per kilowatt hour
95 % capacity factor	
operating and maintenance	1.4 cents per kilowatt hour
uranium costs	0.76 cent per kilowatt hour
direct costs:	2.16 cents per kilowatt hour
(indirect social costs)	
waste disposal	0.1 cent
decommissioning	0.15 cent
[other environmental costs not quantified]	
	total = 3.31 cents per kilowatt hour

from 'Electric Vision' by Robert Preston Sept 7, 2005

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Natural Gas

capital cost	0.42 cent per kilowatt hour
95 % capacity factor	
operating and maintenance	<0.5 cent per kilowatt hour
gas costs	4.90 cents per kilowatt hour
direct costs:	4.95 cents per kilowatt hour
(indirect social costs)	
health costs	2 cents
climate	0.27 cent
	total = 8.09 cents per kilowatt hour

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Solar

capital cost	17.12 cents per kilowatt hour
15 - 20 % capacity factor	
operating and maintenance	1 cent per kilowatt hour
photons cost	nothing
direct costs:	18.12 cents per kilowatt hour
(indirect social costs)	
aesthetic	not quantified
	total = 18.12 cents per kilowatt hour

from 'Electric Vision' by Robert Preston Sept 7, 2005

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Wind Power

capital cost	2.45 cents per kilowatt hour
25 - 35 % capacity factor	
operating and maintenance	1 cent per kilowatt hour
wind costs	nothing
direct costs:	3.14 cents per kilowatt hour
(indirect social costs)	
aesthetic & bird kill	not quantified
	total = 3.45 cents per kilowatt hour

from 'Electric Vision' by Robert Preston Sept 7, 2005

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“Real” total New England costs 6 - 7 cents per kilowatt hour

http://www.awea.org/faq/tutorial/wwt_costs.html

American Wind Energy Association

Free-Flow Tidal Current (Underwater Wind Farm)

capital cost	5 to 8? cents per kilowatt hour
30 - 50 % capacity factor	
operating and maintenance 2?	cents per kilowatt hour
Tidal energy costs	nothing
direct costs:	7 - 10 cents per kilowatt hour
(indirect social costs)	not quantified
	total = 7 - 10 cents per kilowatt hour

from industry estimates in remainder of presentation

- Some can produce renewable power for less than the 8.5 cents/kwh wholesale power market
- Avoids some wholesale power purchases
- Avoids fossil fuel emissions costs
- May garner Production Tax Credits
- Enables sale of Renewable Energy Credits

Submerged Tidal Array

capital cost 5 to 7? cents per kilowatt hour

40 - 60 %? capacity factor

operating and maintenance 1.5? cents per kilowatt hour

Tidal energy costs nothing

direct costs: 6.5 - 8.5? cents per kilowatt hour

(indirect social costs) not quantified

total = 6.5 - 8.5? cents per kilowatt hour

from industry estimates in remainder of presentation

- Appears competitive with 7.24 cents/kwh PSNH generation cost and less than 8.5 cents/kwh wholesale power market
- Avoids some wholesale power purchases
- Avoids fossil fuel emissions costs
- May garner Production Tax Credits
- Enables sale of Renewable Energy Credits

Cost Comparison Summary

Technology	Costs in cents per delivered Killowatt Hour				Estimates shown with question mark?		
	Capital Cost	Capacity Factor	O&M Cost	Fuel Cost	Direct Costs	Indirect Social Costs	Total Costs
Coal	0.72	95%	1	2.14	3.14	6.43	10.29
Nuclear	0.9	95%	1.4	0.76	2.16	0.25	3.31
Natural Gas	0.42	95%	0.5	4.9	4.95	2.27	8.09
Solar	17.12	15 - 20%	1	none	18.12	not quantified	18.12
Wind	2.45	25 - 35%	1	none	3.14	not quantified	3.45
						New England	6 - 7
Tidal							
Barrage / Low Dam	7 - 10?	12 - 18%?	1?	none	8 - 11?	not quantified	8 - 11?
Free-Flow Current	5 - 8?	30 - 50%	2?	none	7 - 10	not quantified	7 - 10
Tidal Fence	6 - 9?	35 - 40%	2?	none	8 - 11?	not quantified	8 - 11?
Submerged Array	5 - 7?	40 - 60%?	1.5?	none	6.5 - 8.5?	not quantified	6.5 - 8.5?

About the author of 'Electric Vision'

Robert S. Preston is a Portfolio Manager in the Personal Investment Advisory program at Merrill Lynch. He has 25 years investment experience with senior positions at AXA, Nomura, Rothschild and Paine Webber. BA from Tulane University and MBA University of Edinburgh, Scotland. In 2001, he founded Craigmillar LLC, an investment company managing energy-related portfolios. In 1979, he founded American Solar Design, Inc., a company that financed, designed, built and managed solar thermal micro-utilities in Northern California. He is a current board member of the Darragh Company, Dover Land Trust and the Northeast Sustainable Energy Association. Robert_Preston@ML.com