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Hydrogen Storage Plant-HSP
 LCOS Algorithm Worksheet for Computing the Levelized Cost of Storing Solar Electricity
Is Hydrogen Energy Storage Ready for Prime Time on the North American Grid?
 Solar Power International 2019 Conference, 23-26 September, Salt Lake City, UT USA
HANDOUT WS # 4-- Summary of HSP Specs and Key Computed Values

Download the paper at <https://tinyurl.com/Stavy-SPI-19>

Spec #	a	d/m/y					
	Foreign Exchange	\$1.14610	13/01/2019				
	quick key to HSP LCOS Algorithm energy flow →	HE produces H ₂	H ₂ Tank stores H ₂	FC consumes H ₂			
		WS # 1	WS # 2	WS # 3			
		HE	H ₂ Tank	FC			
WS # 1	Phase→	charge	storage	discharge	HSP-η-%		
4	HSP Phase-η-%	90%	90%	90%	72.9%		
2	MWh _{ELECT} /day-in	300.00	←MWh _{ELECT} /day solar electricity stored			COLOR CODE	
	MWh _{H2} /day-out	270.00	←MWh _{H2} /day H ₂ produced by the HE			From WS # 1	
	MWh _{H2} /day-in		270.00	←MWh _{H2} /day H ₂ stored		From WS # 2	
	MWh _{H2} /day-out		243.00	←MWh _{H2} /day H ₂ released		From WS # 3	
	MWh _{H2} /day-in			243.00	←MWh _{H2} /day of H ₂ consumed by FC	Result	
	MWh _{ELECT} /day-out			218.70	←MWh _{ELECT} /day solar electricity regenerated	Side Column Result	
			proof ↓	72.9%	←HSP-η-%	in €	
	MWh _{ELECT} /yr of solar energy stored→	109,500	72.9%	79,826	←MWh _{ELECT} /yr of solar energy put back on the grid	0.0%	
	Spec→	1 ↓		16 ↓		enter	
	Phase Operating hrs/day	8	8.00	8	24		
	The phases do not operate at the same time. Total phase time always = 24 hours.						
5	\$/MWh _{ELECT} -in	\$50.00	←US\$/MWh _{ELECT} cost of solar electricity put into storage each day		US\$/kWh ↓	€/MWh ↓	
	\$/MWh _{H2} -out	\$74.92	←US\$/MWh _{H2} LC H ₂ produced by the HE each day		5.00	€ 43.63	
	\$/MWh _{H2} -in		\$74.92	←US\$/MWh _{H2} LC H ₂ put into the H ₂ Tank each day		7.49	€ 65.37
	\$/MWh _{H2} -out		\$110.19	←US\$/MWh _{H2} LC H ₂ discharged from the H ₂ tank each day		11.02	€ 96.14
	\$/MWh _{H2} -in			110.19	←US\$/MWh _{H2} LC H ₂ consumed each day to power the FC		
	\$/MWh _{ELECT} -out			\$152.71	← US\$/MWh _{ELECT} LCOS solar electricity	15.27	€ 133.25
				205.4%	←% increase in the cost of storing the solar electricity		
	HSP HE MW _{ELECT}	37.5	Tank Size	FC Power	€/MW _{ELECT} ↓	€/MWh _{H2} ↓	€/MW _{ELECT} ↓
	HSP HE CapEx-US\$/MW _{ELECT}	\$573,000	MWh _{H2} ↓	MW _{ELECT} ↓	€ 499,956		
	HSP"H2 Tank" CapEx-US\$/MWh _{H2}		\$100,000	27.3		€ 87,252	
	HSP FC CapEx-US\$/MW _{ELECT}			\$1,000,000			€ 872,524
	CapEx -US\$/kW _{ELECT} ; \$\$\$/kW _{H2} ; US\$/kW _{ELECT} →	\$573	\$100	\$1,000			..

	WS # 1 HE	WS # 2 H ₂ Tank	WS # 3 FC	
CapEx -€/kW _{in} ; /kWh; /kW _{out} →	€ 500	€ 87	€ 873	
				Total HSP CapEx
HSP Total CapEx-US\$/Phase	\$21,487,500	\$27,000,000	\$27,337,500	\$75,825,000
HSP Total CapEx-€/Phase	€ 18,748,364	€ 23,558,154	€ 23,852,631	€ 66,159,148
WS # 1				
6	Annual Fixed O&M Cost-% Phase CapEx	0.05%	0.05%	0.05%
7	Variable O & M Cost-US\$/Phase MWh	\$0.25	\$0.25	\$0.25
8	Phase Physical Life -Years	20	20	20
9	Phase Interest/ROE Rate-%	6.00%	6.00%	6.00%

HANDOUT
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HANDOUT Notes

1. This page summarizes the COMPUTED values from WS # 1, 2 and 3
2. The SPEC values were entered on WS # 1, 2 & 3
2. All entries are color coded to show which WS they are from
4. The LCOS is different here than on the poster because a computational error was corrected
5. Questions? Comments? Corrections? Call or email to set up an appointment
7. After the Solar Power International 2019 Convention in Salt Lake City, Michael will be available to meet with clients
8. Download the author's Paper and the paper's Excel HSP LCOS workbook at <https://tinyurl.com/Stavy-SPI-19>

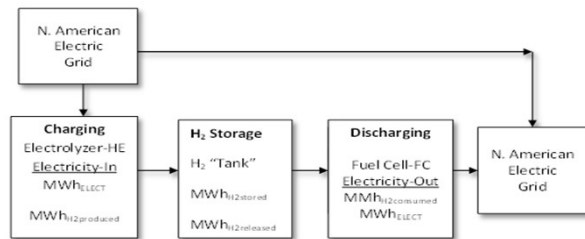


Figure # 1 Schematic of the MODEL HSP (Sorry, the Schematic is sharper in the paper)

Call Michael to set up an appointment at 312-523-8328