LEVELISED COST OF GREEN HYDROGEN GENERATED FROM VARIOUS RE SOURCES: A STUDY FOR INDIA

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INTRODUCTION

Current Study calculates, analyzes and compares the levelized cost of gH2 (LCOH) with energy input from different types of renewable energy sources 1. Solar power, 2. Wind and 3. Wind-Solar Hybrid and 4. RTC RE (Round The Clock RE). Sensitivity analysis is then performed to find out factors that affect the most to LCOH. It is found that the cost of electricity (tariff) and the efficiency of Electrolyser are the major factors that affect the levelized cost of green hydrogen. It was clearly established that other factors like lower Electrolyser cost and higher CUF of RE plant will further lower the LCOH.

OBJECTIVE

- Calculate cost of producing hydrogen through imported Electrolyser and using various RE (Wind, Solar, Hybrid, RTC) sources in India.
- A comparison of LCOH across different RE sources to find out the best RE source for green H2 production.
- Sensitivity Analysis to find out the parameters that affect LCOH the most.

Research Questions

How much does gH2 cost in Rs/kg ?
Which RE source is better for gH2 production?
What factors are affecting cost of gH2 ?

METHODOLOGY

LCOH Calculations

Step-1

Per kg cost of generation was calculated for following cost items for Year 1 to year 25.

O&M Expense
Capital Expense (Dep)
term loan Interest
term loan Principal
working capital Interest
working capital principal
ROE
Electricity Cost

Vital Parameters
RE & Electrolyser = 1 MW
Time Period = 25 Years
Loan Interest = 9%
Loan Period = 13 Years
ROE = 10%
Discount Factor = 10%
RE Source = RTC (SECI)

Step-2

The levelized cost (Rs/kg) was calculated for each cost item by

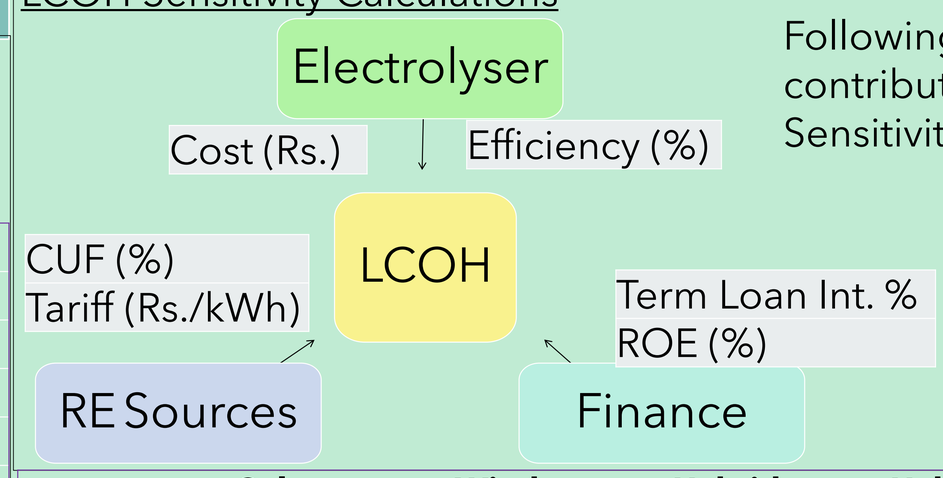
$$LC = \frac{\text{SUM Product of cost of generation}}{\text{SUM of DF weightage for each year}}$$

Step-3

The sum of all the levelized cost items will provide the total cost of goods or LCOH in Rs./kg

INPUT DATA

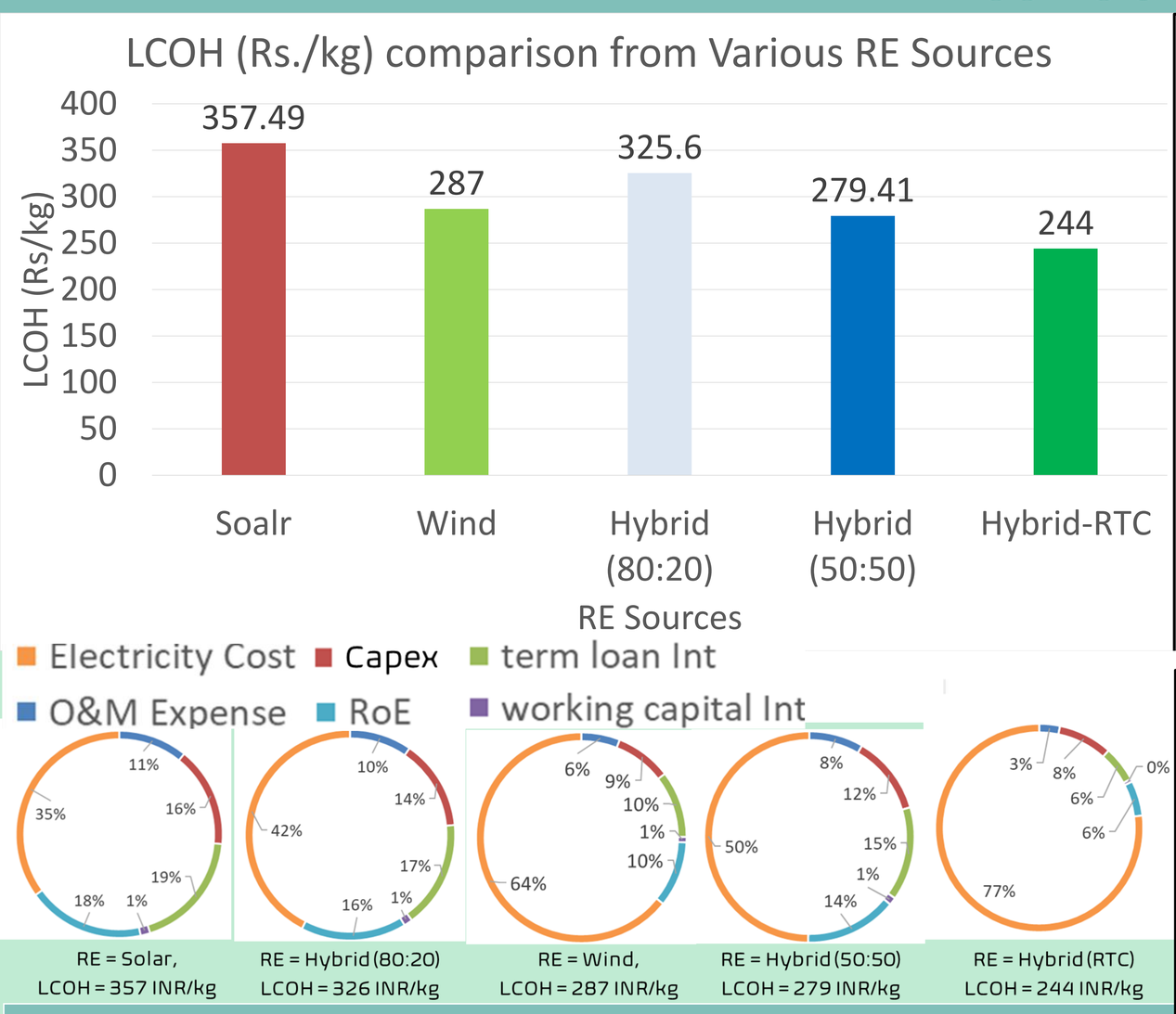
LCOH Sensitivity Calculations



Following are factors contributing to LCOH Sensitivity

	Solar	Wind	Hybrid (80:20)	Hybrid (50:50)	Hybrid RTC (SECI)
Project Cost	INR400 lacs	INR650 lacs	INR480 lacs	INR540 lacs	--
CUF	19%	39%	23%	30%	80%
Period	25 yrs.	25 yrs.	25 yrs.	25 yrs.	25 yrs.
D:E	70:30	70:30	70:30	70:30	70:30
Loan	13 yrs.	13 yrs.	13 yrs.	13 yrs.	13 yrs.
Interest	9.0%	9.0%	9.0%	9.0%	9.0%
ROE	10%	10%	10%	10%	10%
LCOE/ Tariff	2.2 Rs/kWh	3.4 Rs/kWh	2.49 Rs/kWh	2.57 Rs/kWh	2.9* Rs/kWh

RESULTS & DISCUSSION



RE = Solar, LCOH = 357 INR/kg | RE = Hybrid (80:20) LCOH = 326 INR/kg | RE = Wind, LCOH = 287 INR/kg | RE = Hybrid (50:50) LCOH = 279 INR/kg | RE = Hybrid (RTC) LCOH = 244 INR/kg

LCOH Sensitivity Analysis – For Hybrid RTC

Electrolyzer Cost in INR Lakhs /MW \ Electrolyzer Efficiency	50%	55%	60%	65%	70%	75%	80%
300	303	275	252	233	216	202	189
350	310	282	258	239	221	207	194
400	317	288	264	244	227	211	198
450	324	295	270	249	232	216	203
500	331	301	276	255	237	221	207
550	339	308	282	260	242	226	212
600	346	314	288	266	247	230	216
650	353	321	294	271	252	235	221
700	360	327	300	277	257	240	225
750	367	334	304	282	262	245	229
800	374	340	312	288	267	250	234

Electrolyzer Cost in INR Lakhs /MW \ RE electricity Tariff INR /kWh	2 Rs/kWh	2.5 Rs/kWh	3 Rs/kWh	3.5 Rs/kWh	4 Rs/kWh	4.5 Rs/kWh	5 Rs/kWh
300	158	181	204	226	249	271	294
350	164	187	209	232	254	277	299
400	169	192	215	237	260	282	305
450	175	197	220	242	265	287	310
500	180	203	225	248	270	293	315
550	186	208	231	253	276	298	321
600	191	214	236	259	281	304	326
650	196	219	242	264	287	309	332
700	202	224	247	269	292	315	337
750	207	230	252	275	297	320	342
800	213	235	258	280	303	325	348

CONCLUSION

- Lowest LCOH is found to be 244 Rs/kg with RE electricity from hybrid (RTC- SECI)
- Electricity cost is the dominant cost in the production of gH2 and has a higher share (77%) in the LCOH. LCOH decreases as the share of electricity in LCOH increases.
- LCOH can be lowered up to 158 Rs/kg by lowering electricity cost and Electrolyser cost.
- Other than RE tariff, the most sensitive factors for LCOH are CUF of RE plant and efficiency of Electrolyser.
- LCOH of around 1$/kg can be achieved with following inputs.

Electrolyser Cost (INR Lakh)	300	Term Loan Int. %	8%	CUF of RE Plant	80%
Electrolyser Efficiency	90%	ROE	10%	RE electricity Tariff (Rs/kWh)	1

LCOH (Rs/kg) 82.53