

Reforming of Landfill Gas (LFG) for *Blue Hydrogen* Production

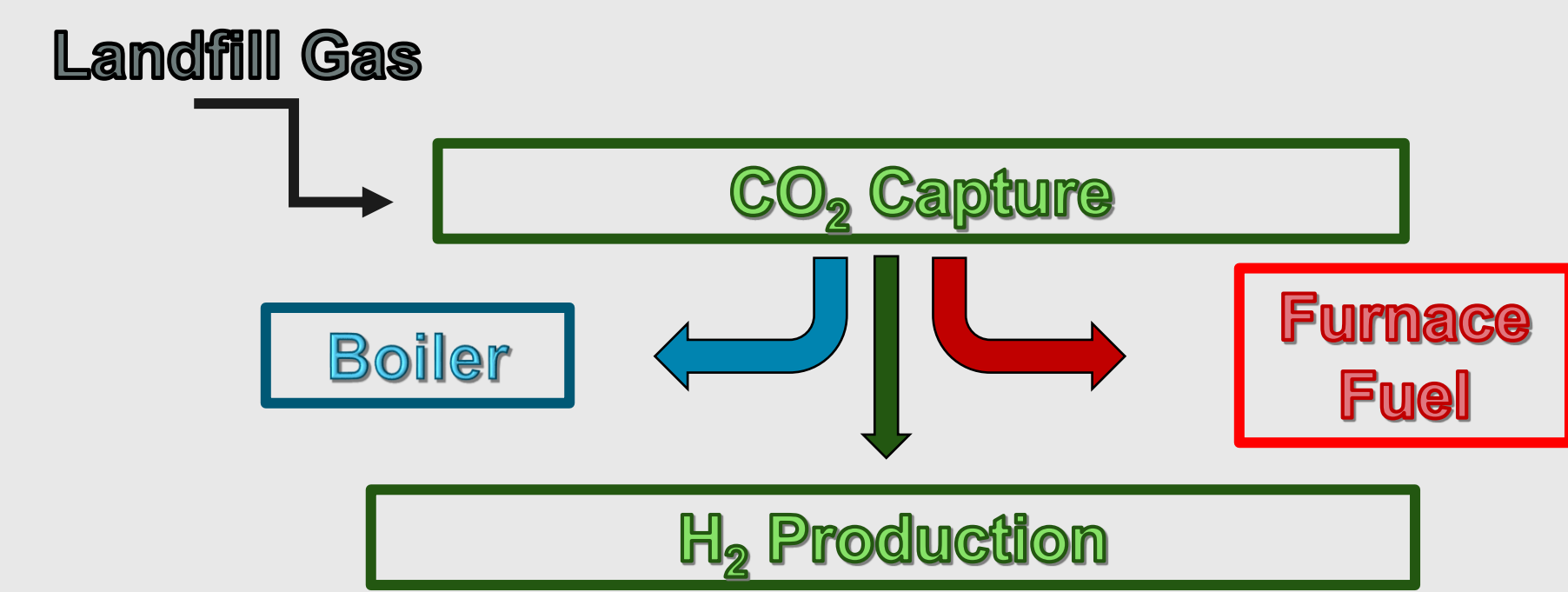
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Background

LFG facilities emit many greenhouse gases (GHG), detrimentally contributing to the effects of climate change. This project aims to convert the methane (CH₄) in LFG to a useful hydrogen gas (H₂) and capture carbon, reducing the emissions and effects on climate change.

Purpose

Design a reforming process for *blue H₂* purification and CO₂ capture of LFG.



Objectives

- Purify LFG, producing a *blue H₂* product.
- Capture 100% of CO₂ & H₂S from feed.
- Regenerate MEA & process steam.
- Have a feasible and safe plant design.
- Be an environmentally conscious design.
- H₂-blending by direct grid-injection.

Design Process

• (1) $CH_4 + H_2O \rightarrow CO + 3 H_2$
 $\Delta H_1 = +207 \frac{kJ}{mol}$

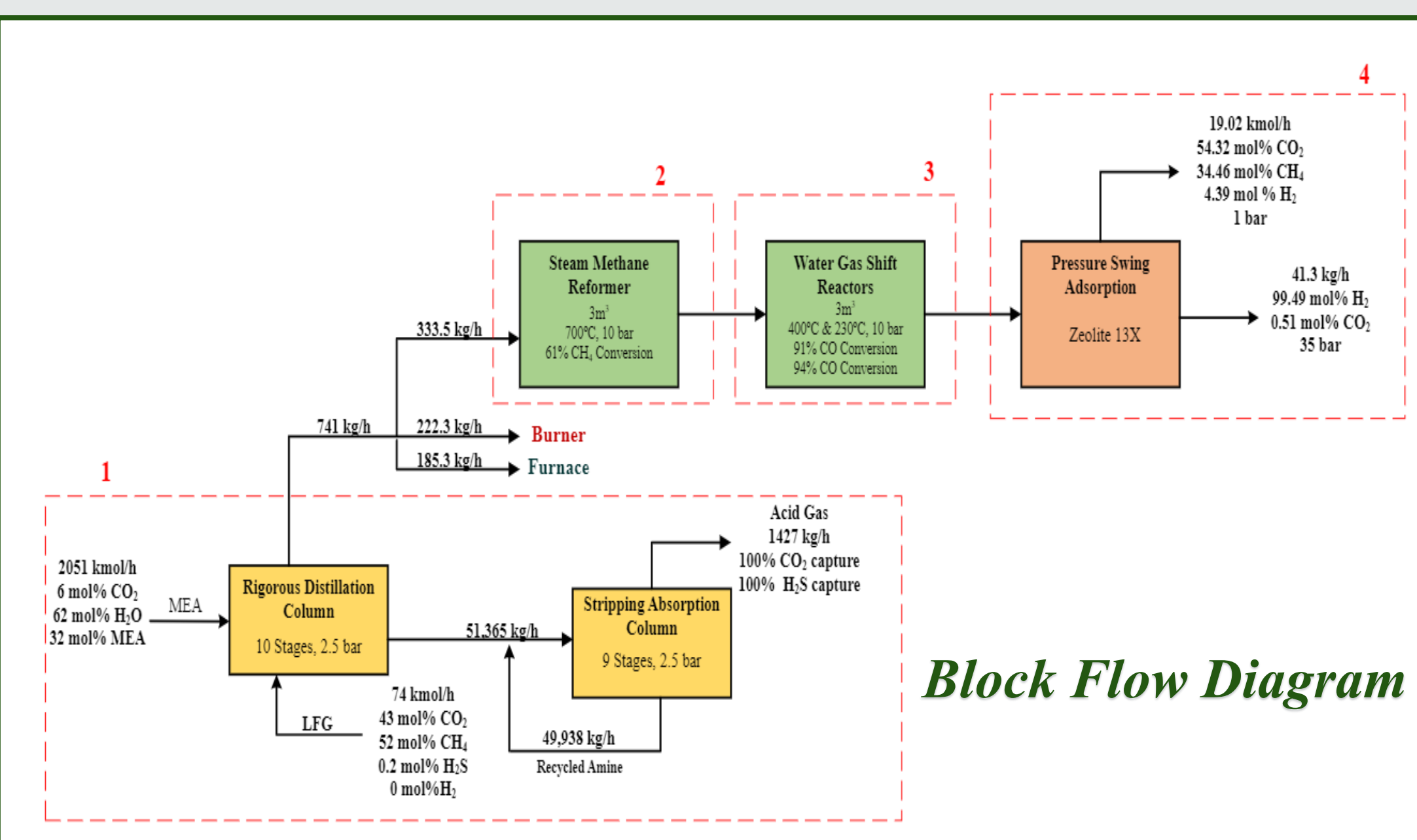
• (2) $CH_4 + \frac{1}{2} O_2 \rightarrow CO + 2 H_2$
 $\Delta H_2 = -36 \frac{kJ}{mol}$

Steam Methane Reformer (SMR)

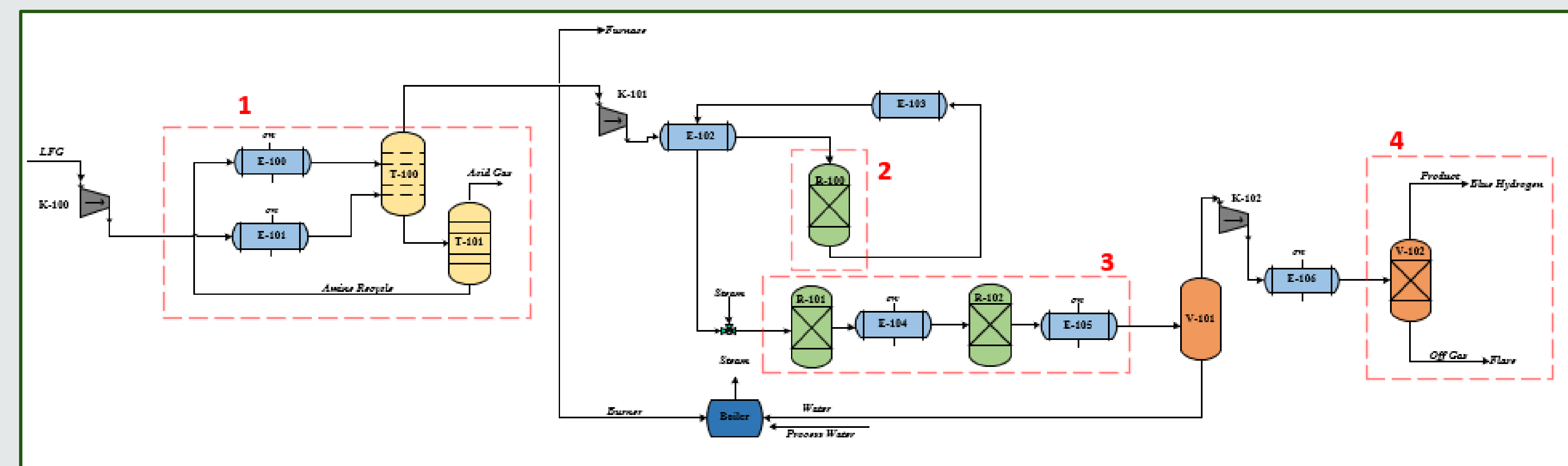
Water Gas Shift Reactor (WGSR)

• (3) $H_2O + CO \rightarrow CO_2 + H_2$
 $\Delta H_3 = -41.4 \frac{kJ}{mol}$

The main reactions take place in the reformer and reactor after H₂S removal and CO₂ capture.



Details of Design



Carbon Capture & Desulfurization Unit

Process in which H₂S is removed from the LFG feed, and CO₂ is captured by amine absorption and a ZnO-bed.

Steam Methane Reformer (SMR)

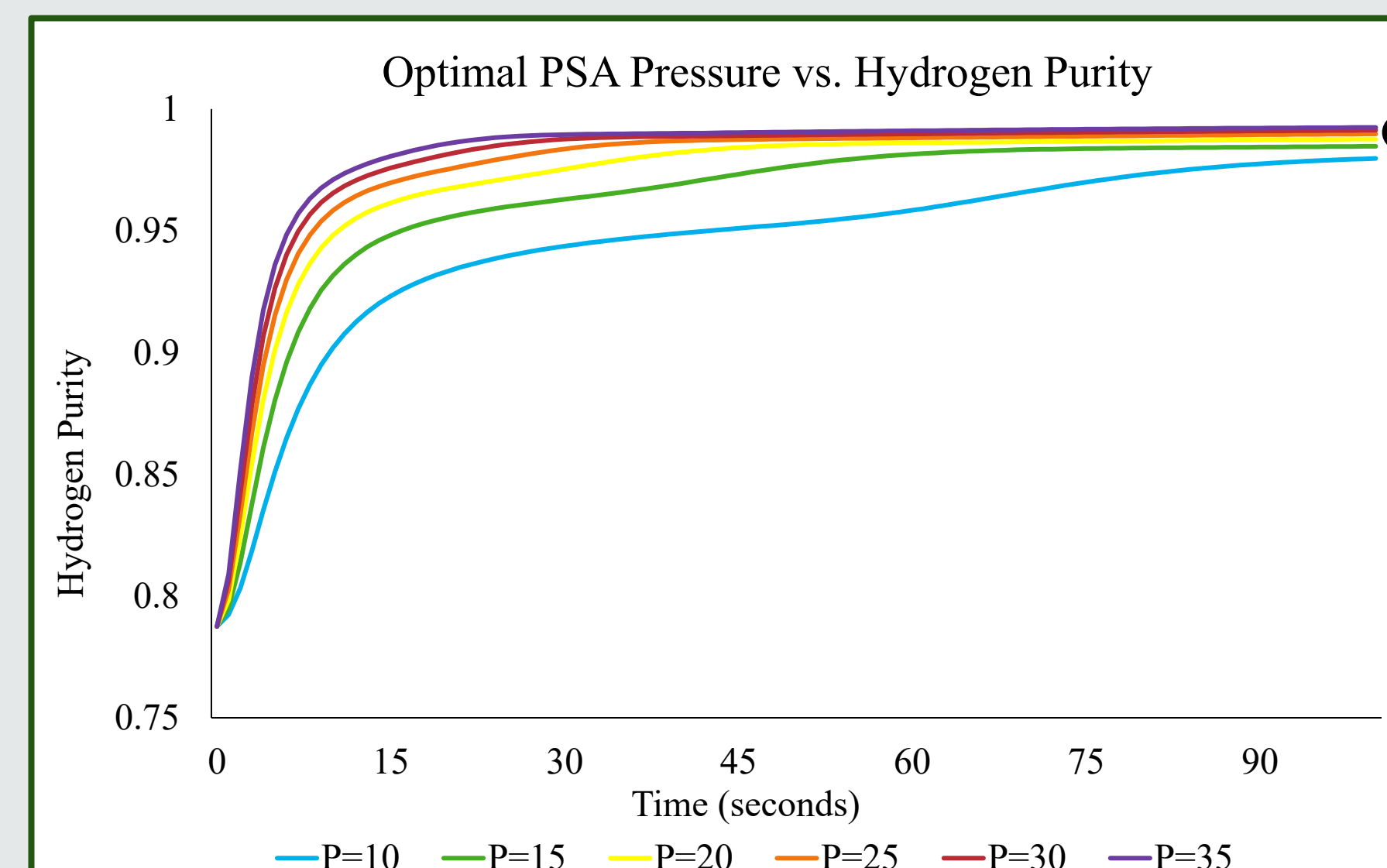
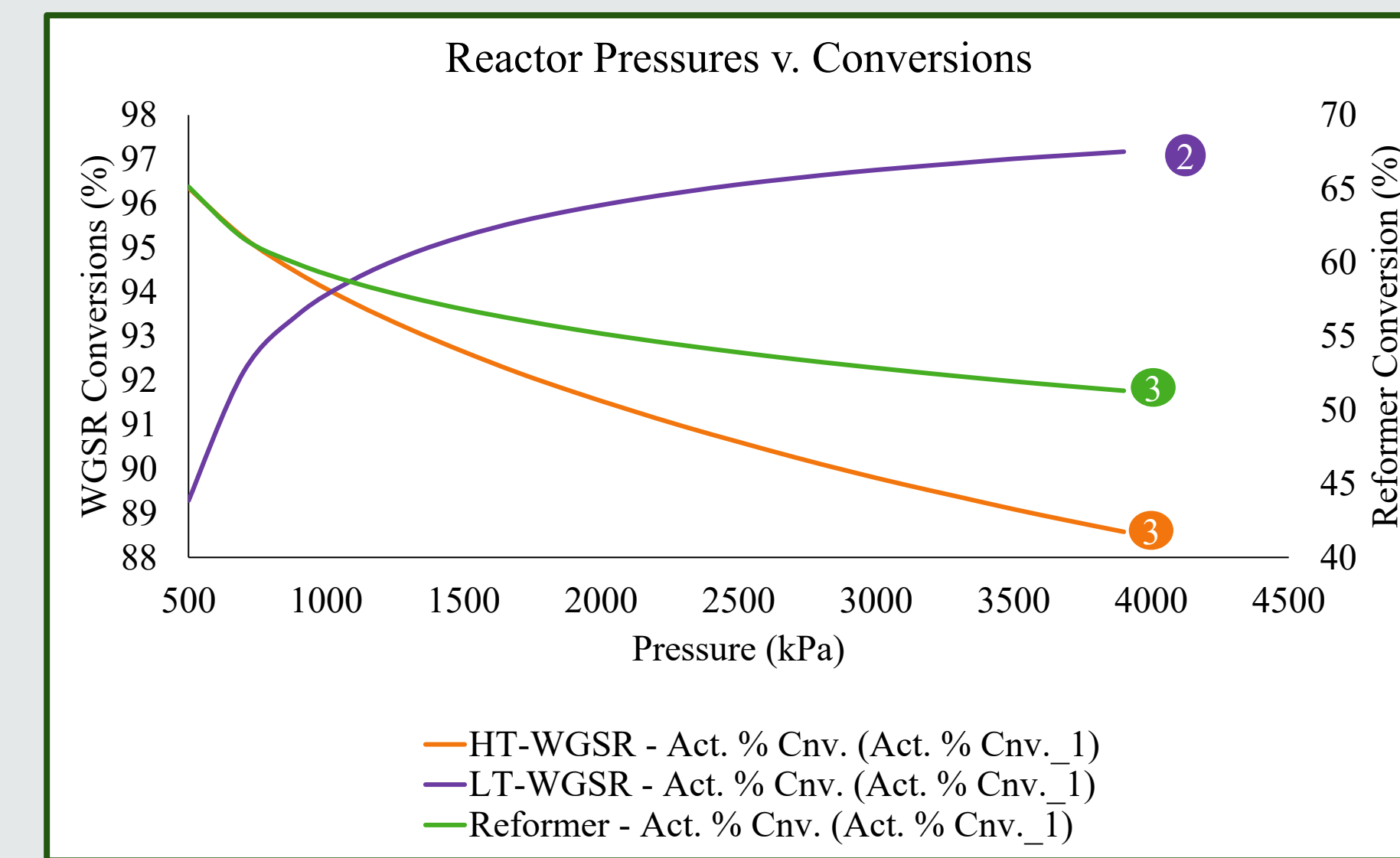
A packed bed reactor where CH₄ from the LFG is being converted to CO and H₂ gas.

Water-Gas Shift Reactor (WGSR)

A two-stage process where CO and H₂O (steam) exothermically react to produce CO₂ & H₂ at ~90% conversions in each packed-bed reactor.

Pressure Swing Adsorption (PSA)

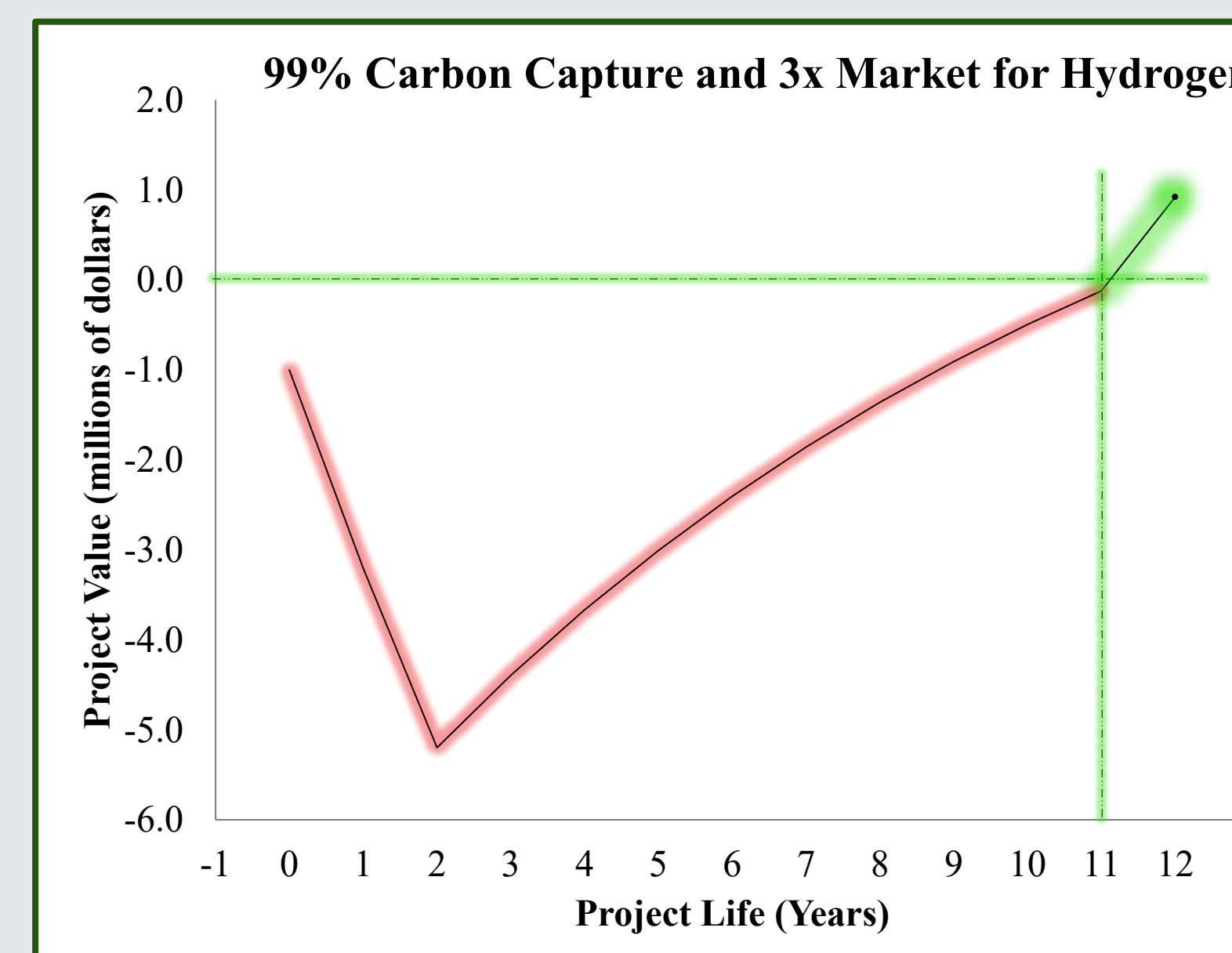
A series of adsorption columns packed with Zeolite 13X to capture residual components and obtain a 99% purity H₂ product.



Conclusion & Recommendations

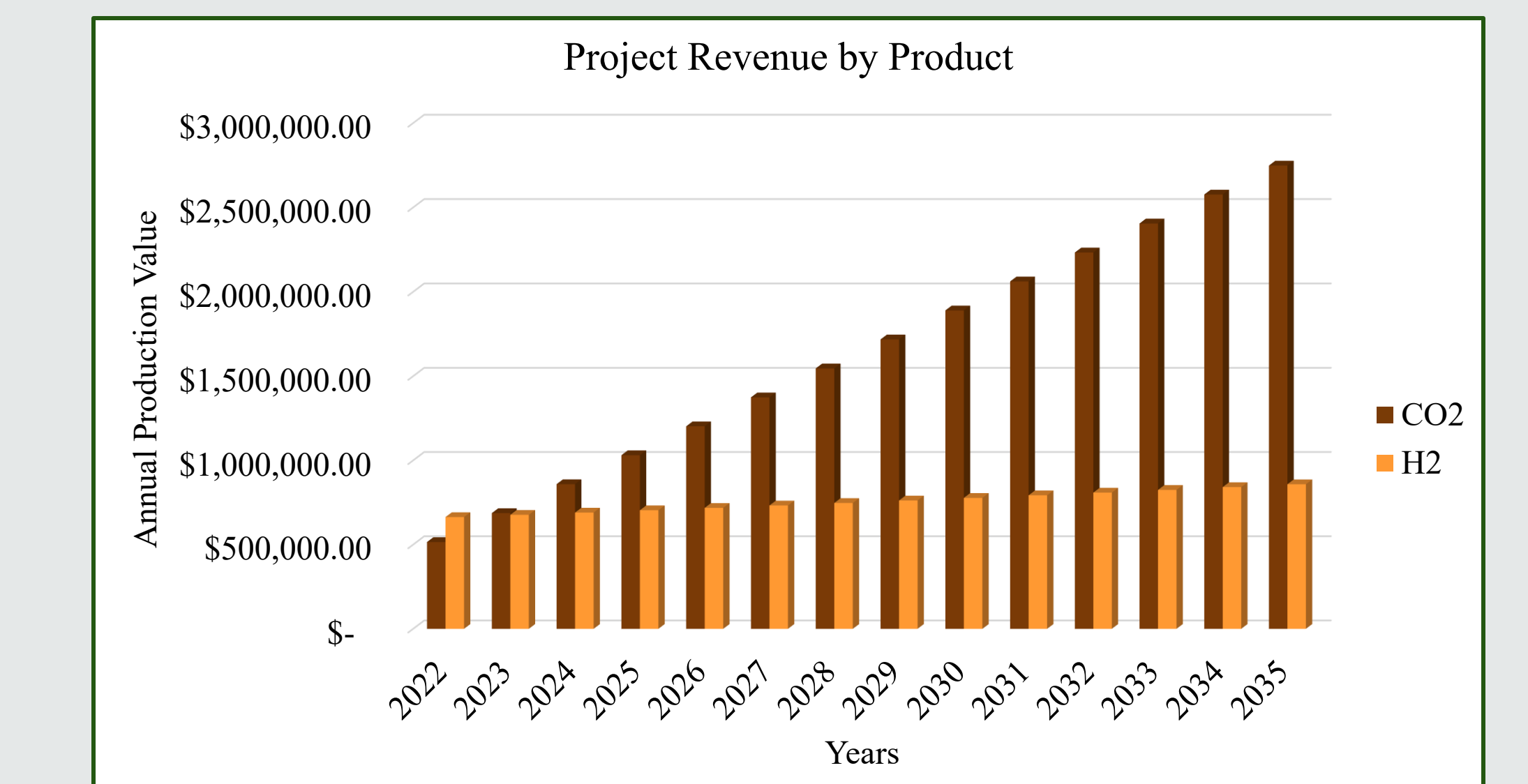
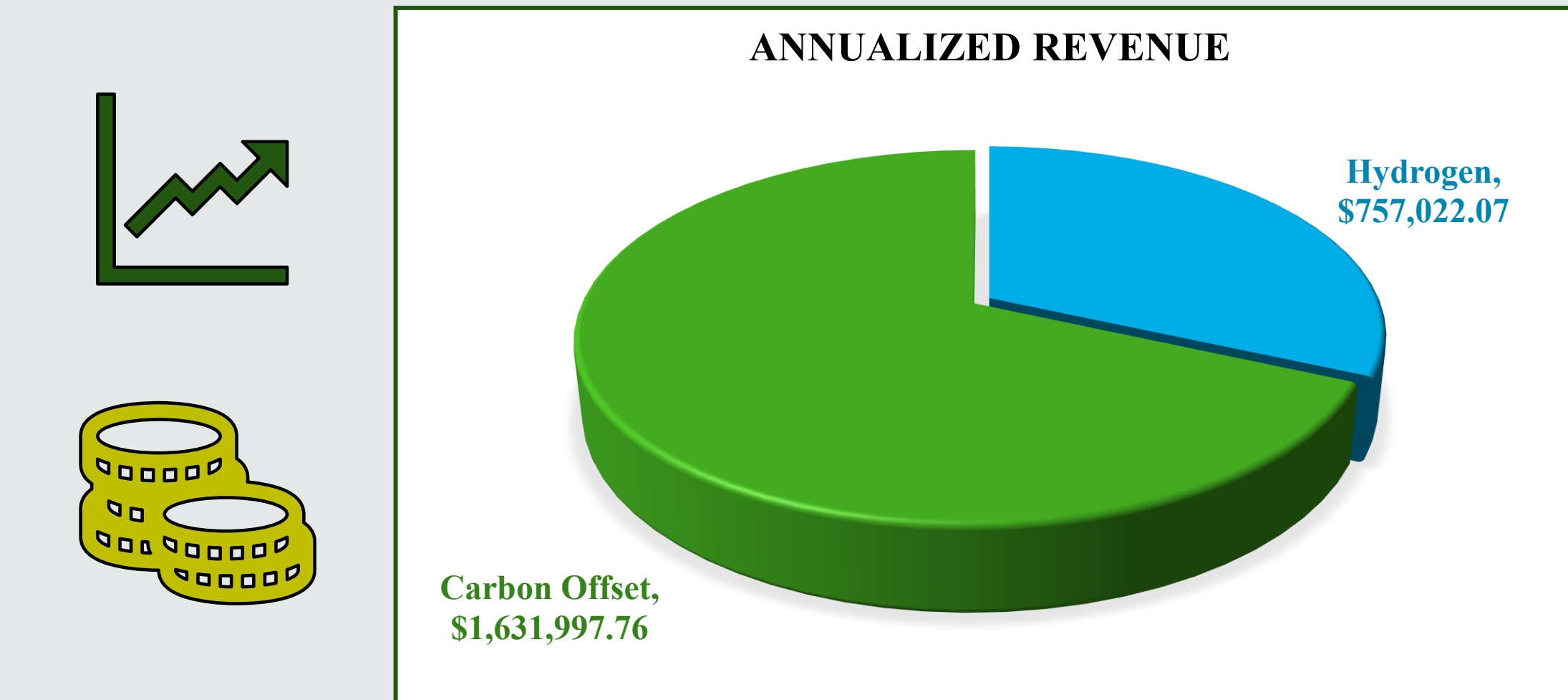
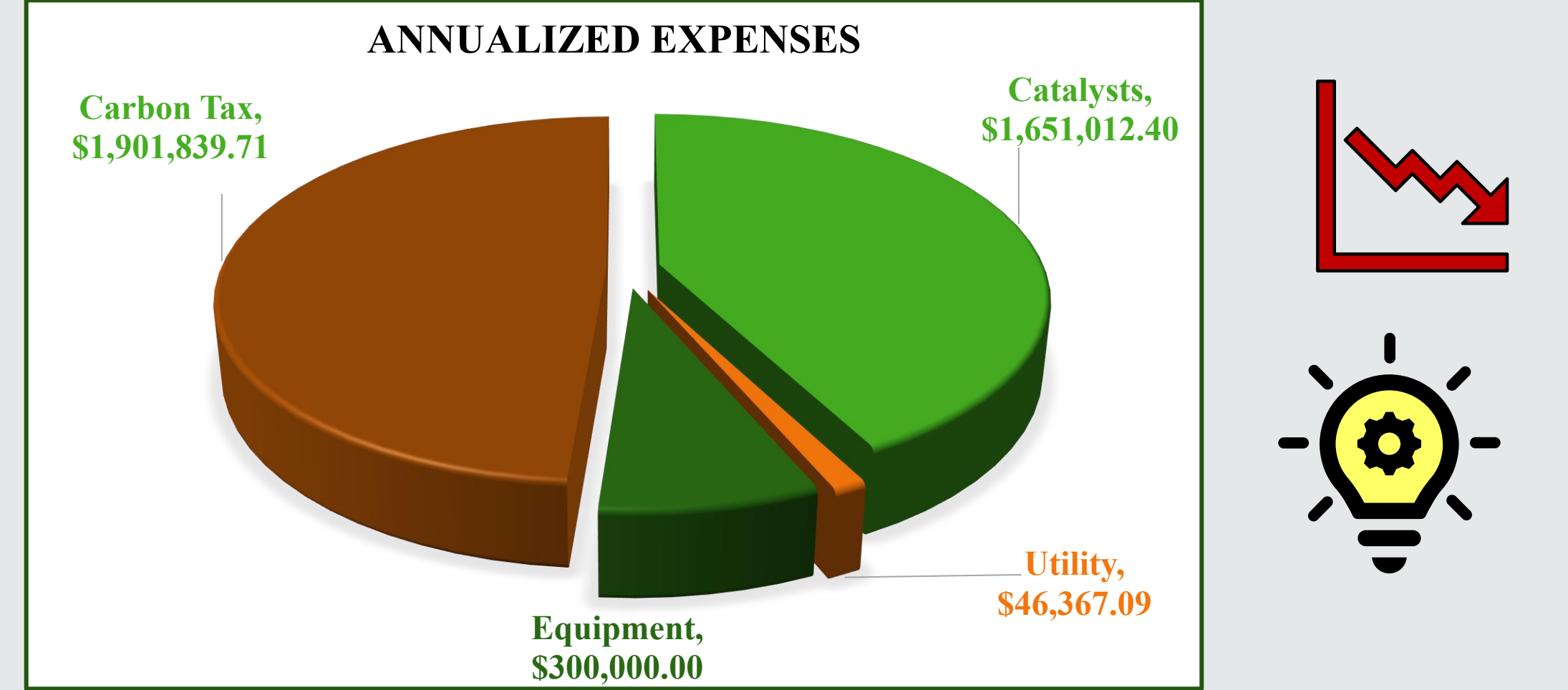
- Carbon credits are **immensely valuable** over time
- A **secondary carbon capture system** is recommended (99%+)
- Annual H₂ production → **670,000 kg**
- 10-Year annualized revenue is **\$488K/year**
- Gas turbine is **more economically** favoured in today's market
- Initial projects costs are not recoupable

BAU	24,582	[tCO ₂ e/year]
Carbon Capture	11,452	[tCO ₂ e/year]
Net Emissions	13,420	[tCO ₂ e/year]
Hydrogen Produced	670	[tonnes/year]

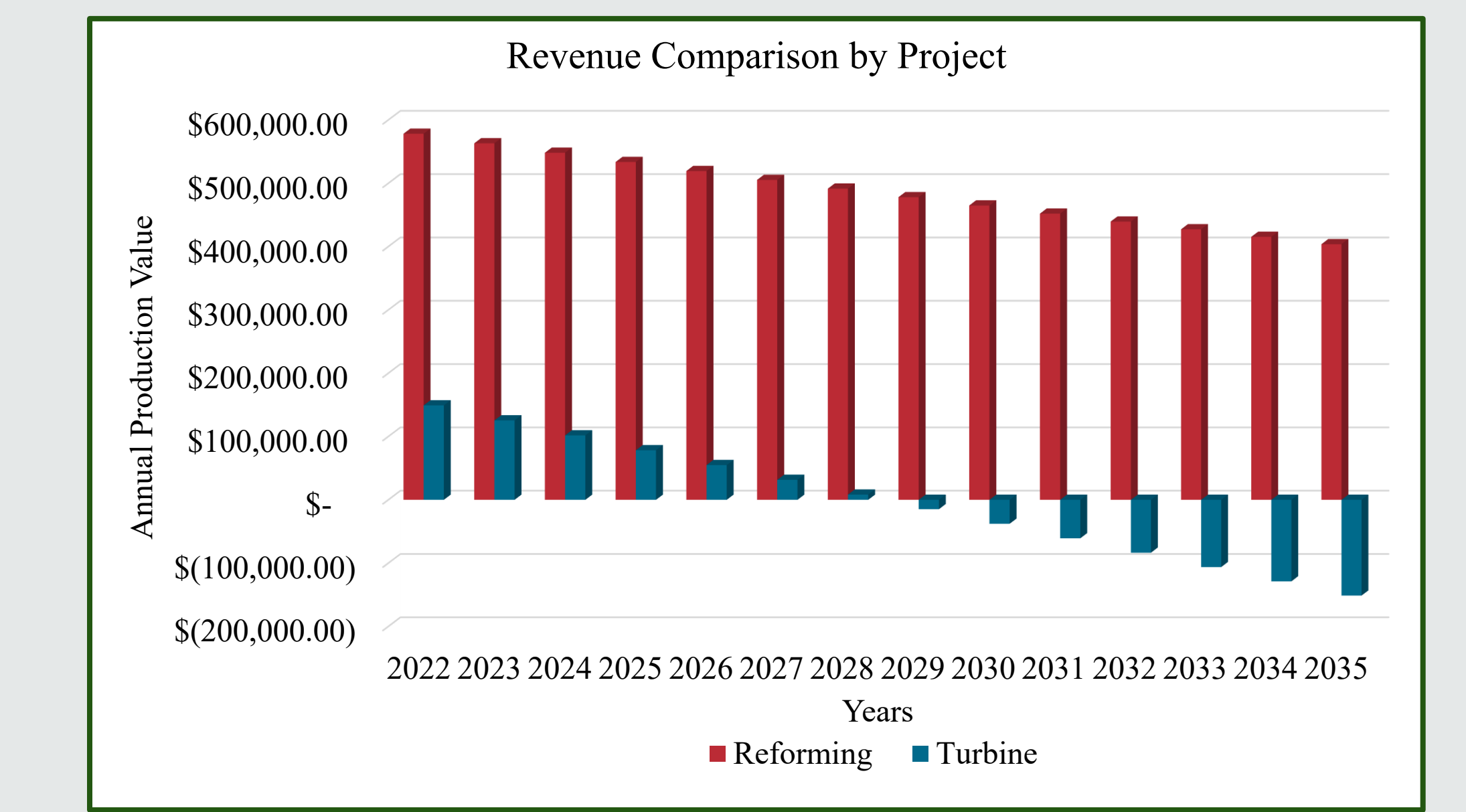


2,500 Cars ↔ **CO₂ Capture**

Economic Analysis



Years	Hydrogen	Carbon Offset	Carbon Tax	Net Carbon	Revenue
2022	\$663,475.02	\$515,367.71	-\$600,580.96	-\$85,213.25	\$578,261.78
2035	\$858,275.69	\$2,748,627.80	-\$3,203,098.46	-\$454,470.65	\$403,805.04
Δ	\$194,800.67	\$2,233,260.09	-\$2,602,517.50	-\$369,257.41	-\$174,456.74



Safety Considerations

Toxic

Flammable

Overpressure

Runaway Reactions