Problem to be addressed
Population growth drives increased human activity and solid waste production, shifting focus to produce sustainable energy from solid waste. Hydrogen emerges as a promising alternative energy carrier for clean and sustainable solutions.

Motivation
Calgary’s hydrogen demand projected to reach 5,043 tonnes/day, offering a $4.6 billion market opportunity.

Goal
Develop a gasification plant to generate 15 tonnes/day of pure hydrogen (99.99%) while diverting landfill waste through use of paper waste feedstock and minimizing GHG emissions through CCS and use of biomass feed.

Safety and Environment

<table>
<thead>
<tr>
<th>Risks</th>
<th>Mitigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasifier fouling, slagging and corrosion</td>
<td>1 Pretreatment to remove alkalis and sulfur</td>
</tr>
<tr>
<td>Over/under pressurization (air ingress + gas release)</td>
<td>2 Pressure relief valves and air monitoring</td>
</tr>
<tr>
<td>Hydrogen embrittlement</td>
<td>3 Special storage tank lining materials</td>
</tr>
</tbody>
</table>

Comparison of Lifecycle GHG Emissions

Cost Breakdown

- **Capital Investment**: $66.4 MM
- **Annual Operating Expense**: $42.7 MM

Key Financial Indicators

- **NPV**: $80.7 MM
- **IRR**: 15.6%
- **Payout Period**: 7.4 yrs

Sensitivity Analysis

- **Estimated hydrogen production cost**: $7.87/kg H₂
- **Estimated nitrogen-rich ash revenue**: $45.00/MM yr

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CONCLUSION

This process achieves GHG emission reduction, landfill diversion, and hydrogen production (clean fuel).

The cost of hydrogen production ($7.87/kg H₂) is quite high (compared to Steam Methane Reforming [$1.34/kg H₂]). Need reduction in electricity usage and ‘cost of feedstock’.

Direct process emissions are comparable to SMR if paper is not a true negative carbon source, and diverted methane emissions can not be counted.

You may contact the group leader: noor.awan@ucalgary.ca for further questions. Questions will be directed to the appropriate team member.