Current Initiatives for Electrolytic H$_2$ Production at HySA Infrastructure

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http://www.hysainfrastructure.org/
Coal supplies ~75% of South Africa’s primary energy and 90% of its electricity requirements.

Domestic consumption of coal amounts to ~171 million tons (~100 mt for electricity and ~70 mt for synfuels) and ~69 million tons is exported (annually).

- RSA has energy intensive economy
- RSA has a large SO₂/CO₂ footprint
- RSA’s CO₂ footprint per capita ranks among the top 12 in the world
- Large SO₂ footprint

*CR&W: Combustible Renewable and Waste
Source: International Energy Agency (IEA)
Solar Energy Potential in South Africa

In SA:
- AVERAGE: 4.5 – 5 kWh/m²/day
- 1 kW/m² for a 5.5 hour day
- 245 GW capacity
- 834 TWh @ 39 % capacity factor

South Africa is the dominant PGM supplier

- South Africa: 79%
- Russia: 12%
- North America: 5%
- Others: 4%

PGM Supply by region
Strategic Goals

- Develop local cost competitive hydrogen generation solution based on renewable resources

- Wealth creation through value added manufacturing of PGM catalysis, goal: supply 25% of PGM catalysts demand by 2020

- Promote equity and inclusion in the economic benefits of South Africa’s resources, SMEs to play an important role

PEM Electrolysers: Development strategy

Why PEM electrolysers?

1. High PGM content as platform for beneficiation.
2. PEM electrolysers are robust and dynamic: fast response to volatile renewable energy sources.
3. Can generate practical high discharge H₂ pressure.
4. Dynamic profile of H₂ production rate meeting various requirements.
5. Large-scale: addressing demand for energy storage.

Presented by the author at F-Cell, 2012, Stuttgart
PEM Electrolysers: Gen 1 high-level TDM targets (2012/13) (Gen 2 high-level targets are under review)

1. Energy cost (strongly depends on electricity price in $/kWh). $/gge : gallon gasoline equivalent ~ 1 kg H2
2. Dependent on design and capacity.
3. Need to specify stationary or transient operations (e.g., linked to renewables).
4. Shut-down at least 4 times/day when system fully charged.
5. Dispensing volume in range practical for target application.
7. Development of advanced seals required.
8. Membrane integrity and high T requires development.
10. Trade of with costs, efficiency, durability.

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameter</th>
<th>Unit</th>
<th>SOTA</th>
<th>Gen 1 HySA targets</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Cost</td>
<td>H2 production costs</td>
<td>$/kg</td>
<td>0.9-10</td>
<td>0.9-3</td>
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<td></td>
<td>Capital investment</td>
<td>$/kg-H2 over operating life</td>
<td>0.6</td>
<td>0.3</td>
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<td>Durability</td>
<td>Operating life</td>
<td>hrs</td>
<td>10,000-20,000</td>
<td>50,000 - 100,000</td>
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<td></td>
<td>Operating cycle</td>
<td>Energise/deenergise cycles</td>
<td>5800</td>
<td>&gt;170000</td>
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<tr>
<td>Performance</td>
<td>H2 production rate</td>
<td>kg H2/hr</td>
<td>0-10</td>
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<tr>
<td></td>
<td>Power</td>
<td>Kw</td>
<td>0-500</td>
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<tr>
<td></td>
<td>Energy efficiency (enthalpic)</td>
<td>%</td>
<td>80% at 1 A/cm²</td>
<td>80% at 2-3 A/cm²</td>
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<tr>
<td></td>
<td>H2 compressed pressure</td>
<td>bar</td>
<td>15-50</td>
<td>250</td>
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<tr>
<td>Operating Conditions</td>
<td>Operating Cell Temperature</td>
<td>Deg C</td>
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<td>60-80</td>
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<td></td>
<td>Operating current density</td>
<td>A/cm²</td>
<td>&gt;3</td>
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<td></td>
<td>Voltage</td>
<td>V/cell</td>
<td>1.8/cell</td>
<td>1.65/cell</td>
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<td>PGM loading</td>
<td>Anode/Cathode total PGM loading</td>
<td>mg/cm²</td>
<td>2 to 5</td>
<td>0.3</td>
<td>10</td>
</tr>
</tbody>
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International Team Contribution 2012

Fuel Cells and associated H₂ Infrastructure represent a new market which could drive growth for platinum as well as spark significant new opportunities internationally and locally in SA.

HySA depends on Government funding so far.

Benefits of developing H₂ infrastructure and fuel cell market in SA:

• Means of meeting increasing demand for energy,
• Reduction of carbon footprint,
• Platform for mineral beneficiation,
• Opportunity for job creation,
• Export opportunities,
• Increase demand for platinum group metals.

Power-to-Gas is a new complex technology that uses renewable H₂ and could become fastest growing technology utilizing electrolytic hydrogen, thus significantly increasing demand for large electrolyzes.