

# H2A Hydrogen Production Analysis Tool

For BILIWG and PURIWG Preliminary  
Cost Analyses

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# H2A Overview

- Discounted cash flow analysis tool for production of hydrogen from various feedstocks
  - Inputs are;
    - Capital costs
    - Operating costs
    - Financial parameters
  - Outputs are cost of hydrogen (\$/kg) and yearly breakdown of costs and revenue

# H2A Hydrogen Analysis Tool - Structure

- Excel spreadsheet based
- Spreadsheet tabs for:
  - Information about the process
  - Feedstock prices and physical properties
  - Calculations
  - Cost and financial parameter input
  - Results
- Color coding

|    |                     |
|----|---------------------|
| 4  |                     |
| 5  | <b>COLOR CODING</b> |
| 6  |                     |
| 7  |                     |
| 8  |                     |
| 9  |                     |
| 10 |                     |

# H2A Hydrogen Analysis Tool – Information Spreadsheets

## Information about the process

- Title
- Description
- Performance assumptions
- Process flowsheet
- Stream summary
- Forecourt parameters
- Daily H2 demand profile

## Feedstock prices and physical properties

- Feedstock & Utility Prices
- Physical Property Data

# H2A Hydrogen Analysis Tool – Calculation Spreadsheets

- Cash Flow Analysis
- Debt Financing Calculations
- Depreciation

# H2A Hydrogen Analysis Tool – Input Spreadsheets

Financial Inputs

Cost Inputs

- Capital costs
- Fixed operating costs
- Variable operating costs

Replacement Costs

# H2A Hydrogen Analysis Tool – Financial Inputs

|    |                                               |                   |                         |                                          |                |
|----|-----------------------------------------------|-------------------|-------------------------|------------------------------------------|----------------|
| 9  | <b>ECONOMIC ASSUMPTIONS:</b>                  |                   |                         |                                          |                |
| 10 |                                               | <b>Base Case:</b> | <b>H2A Guidelines:</b>  | <b>Values in Reference Study:</b>        | <b>Comment</b> |
|    | Reference Year \$ (in half-decade increments) | 2005              | Half-decade increments, |                                          |                |
| 11 |                                               |                   | 1                       | <b>Forecourt Hydrogen Production</b>     |                |
|    |                                               |                   | 2                       | <b>Title</b>                             |                |
| 12 | Assumed start-up year                         | 2005              | 3                       |                                          |                |
| 13 | After-tax Real IRR (%)                        | 10.0%             | 4                       |                                          |                |
| 14 | Depreciation Type                             | MACRS             | 5                       | <b>COLOR CODING</b>                      |                |
| 15 | Depreciation Schedule Length (years)          | 7                 | 6                       |                                          |                |
| 16 | Analysis period (years)                       | 20                | 7                       |                                          |                |
| 17 | Plant life (years)                            | 20                | 8                       |                                          |                |
| 18 |                                               |                   | 9                       |                                          |                |
| 19 | Inflation rate (%)                            | 1.9%              | 10                      |                                          |                |
| 20 | State Taxes (%)                               | 6.0%              | 11                      |                                          |                |
| 21 | Federal Taxes (%)                             | 35.0%             | 12                      |                                          |                |
| 22 | Total Tax Rate (%)                            | 38.9%             | 13                      |                                          |                |
| 23 | Plant Design Capacity (kg of H2/day)          | 1,500.00          | 14                      |                                          |                |
|    |                                               |                   | 15                      |                                          |                |
|    |                                               |                   | 16                      |                                          |                |
|    |                                               |                   | 17                      |                                          |                |
|    |                                               |                   | 18                      |                                          |                |
|    |                                               |                   | 19                      |                                          |                |
|    |                                               |                   | 20                      | <b>Plant Design Capacity (kg/day):</b>   |                |
|    |                                               |                   | 21                      | <b>Start-up Year:</b>                    |                |
|    |                                               |                   | 22                      | <b>Primary Product Feedstock Source:</b> |                |
|    |                                               |                   | 23                      | <b>Secondary Feedstock Source:</b>       |                |

Not on the Financial Inputs sheet!

Enter Plant Design Capacity on Title Sheet!

# H2A Hydrogen Analysis Tool – Financial Inputs

| <b>Financial Default values</b>                             |       |
|-------------------------------------------------------------|-------|
| Reference Year \$ (in half-decade increments)               | 2005  |
| After-tax Real IRR (%)                                      | 10.0% |
| Depreciation Type                                           | MACRS |
| Depreciation Schedule Length (years)                        | 7     |
| Analysis period (years)                                     | 20    |
| % Equity Financing                                          | 100%  |
| % Debt Financing                                            | 0%    |
| Length of Construction Period (years)                       | 1     |
| Capital spent during construction. Enter 100% in this cell  | 100%  |
| Salvage value (% of total capital investment)               | 0%    |
| Decommissioning costs (% of depreciable capital investment) | 0%    |

Change  
to 1  
year

# H2A Hydrogen Analysis Tool – Case Specific Financial Inputs

| Case Specific Financial Input Values                                   |                                                                            |
|------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Assumed startup year                                                   | 2005 – current; 2012 and 2017 – MYPP targets                               |
| Plant life                                                             | Match plant life and replacement schedule to analysis period (20 y)        |
| Operating capacity factor (%)                                          | Explain if different from 70% forecourt value                              |
| Start time (years)                                                     | Explain differences from ½ year assumed value                              |
| Percent of revenue, fixed and variable operating costs during start-up | Explain differences from values in baseline case (50%, 50%, and 75% resp.) |

# H2A Hydrogen Analysis Tool – Default Cost Inputs\*

| Default Input Values – Depreciable Capital Costs |                                                                                                         |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Site preparation                                 | \$74,344 - Site Prep w/ GC: fire walls, foundations, etc. plus 20% for construction expenses and GC fee |
| Engineering & design                             | \$30,000 – explain if different                                                                         |
| Process contingency                              | \$0                                                                                                     |
| Project contingency                              | 10% of direct depreciable capital investment                                                            |
| Other depreciable capital                        | \$0                                                                                                     |
| One time licensing fees                          | \$0                                                                                                     |

\*Default cost input is for a 1500 kg/day station unless otherwise noted

# H2A Hydrogen Analysis Tool – Default Cost Inputs cont.

| Default Input Values – Non Depreciable Capital Costs |                                                      |
|------------------------------------------------------|------------------------------------------------------|
| Non-depreciable capital costs                        | \$0 - Land is assumed to be leased.                  |
| Default Input Values – Fixed Operating Costs         |                                                      |
| Production unit labor                                | 0                                                    |
| Storage/dispensing labor (h/y)                       | 1231.9                                               |
| Storage/dispensing labor cost (\$/h)                 | 15                                                   |
| Overhead and G&A rate                                | 20% of total labor cost                              |
| Property tax and insurance                           | 2% of total capital                                  |
| Rent                                                 | \$43,194 (large station)<br>\$13,236 (small station) |

# H2A Hydrogen Analysis Tool – Default Cost Inputs cont.

| Default Input Values – Fixed Operating Costs cont. |                                                                                                                                                           |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Licensing, permits & fees                          | \$1000                                                                                                                                                    |
| Production maintenance & repairs (\$/yr)           | 5% of Production deprec. cap Inv.<br>3% of Compression deprec. cap<br>1% of Storage deprec. cap<br>\$800/dispenser (3 dispensers for 1500 kg/day station) |
| Forecourt maintenance & repairs (\$/yr)            | \$0 – see above                                                                                                                                           |
| Other fees and Other fixed O&M                     | \$0 – explain if different                                                                                                                                |

# H2A Hydrogen Analysis Tool – Default Cost Inputs cont.

| Default Input Values – Variable Production Costs |                                                                                          |
|--------------------------------------------------|------------------------------------------------------------------------------------------|
| Electricity (\$/kWh)                             | Used as a utility. Select “Commercial Electricity” from the dropdown list and enter 0.08 |
| Natural gas (\$/Nm3)                             | \$0.18                                                                                   |

| A                                                               | B                      |                |
|-----------------------------------------------------------------|------------------------|----------------|
| <b>Utility Costs</b>                                            |                        |                |
| Type of <b>electricity</b> utility used                         | Commercial Electricity | Dropdown lists |
| Use H2A electricity utility cost? (Enter yes or no)             | No                     |                |
| Enter electricity utility cost if NO is selected above (\$/kWh) | 0.08                   |                |
| Electricity utility consumption (kWh/kg H2)                     | 2.17000405             |                |
| Electricity utility cost in startup year (\$/year)              | \$63,316               |                |

Always select “No”

# H2A Hydrogen Analysis Tool – Default Cost Inputs cont.

| Default Input Values – Variable Production Costs cont |                                 |
|-------------------------------------------------------|---------------------------------|
| Ethanol                                               | \$0.283/L (\$1.07/gal)          |
| Sugar                                                 | \$0.064/lb                      |
|                                                       |                                 |
| Process water                                         | \$0.00044/L                     |
| Cooling water                                         | \$0.000021/L                    |
| Demineralized water                                   | \$0.00132/L                     |
| Steam                                                 | \$0.01/kg (LHV = 0.00283 GJ/kg) |

# H2A Hydrogen Analysis Tool – Default Cost Inputs cont.

| Default Input Values – Variable Production Costs cont       |       |
|-------------------------------------------------------------|-------|
| Other variable operating costs (\$/yr)                      | 1,800 |
| Royalties; Operator profit; Subsidies; Carbon sequestration | \$0   |
| Byproduct credits                                           | \$0   |
| Working capital (% change in yearly operating costs)        | 15    |

# H2A Hydrogen Analysis Tool – Case Specific Cost Inputs

## Direct Capital Costs

|    | A                                                           | B                             | C                        | D                               | E                                |
|----|-------------------------------------------------------------|-------------------------------|--------------------------|---------------------------------|----------------------------------|
| 8  | <b>CAPITAL INVESTMENT (Inputs REQUIRED In Year 2005 \$)</b> |                               |                          |                                 |                                  |
| 9  | <b>Production: Major Items</b>                              | <b>Installed</b>              |                          | <b>Installation Cost Factor</b> | <b>Calculated Installed Cost</b> |
| 10 |                                                             |                               |                          |                                 |                                  |
| 11 | Production Unit including housing                           |                               |                          | 1.10                            | \$1,422,384                      |
| 12 |                                                             |                               |                          |                                 | \$0                              |
| 13 |                                                             |                               |                          |                                 | \$0                              |
| 14 | A                                                           |                               |                          | D                               | E                                |
| 15 | <b>Compression/Storage/Dispensing: Major items</b>          | <b>Installed Costs</b>        | <b>Uninstalled Costs</b> | <b>Installation Cost Factor</b> | <b>Calculated Installed Cost</b> |
| 16 | 25                                                          |                               |                          |                                 |                                  |
| 17 | 26                                                          | (Add in lines as appropriate) |                          |                                 |                                  |
| 18 | 27                                                          | H2 Compressor Subsystem       | \$286,250                | 1.2                             | \$343,500                        |
| 19 | 28                                                          | H2 Storage Subsystem          |                          | 1.1                             | \$1,073,625                      |
| 20 | 29                                                          | Dispenser System              |                          | 1.2                             | \$80,640                         |
| 21 |                                                             |                               |                          |                                 |                                  |
| 22 |                                                             |                               |                          |                                 |                                  |
| 23 |                                                             |                               |                          |                                 |                                  |

Production  
Unit  
Equipment  
Costs

Compression,  
storage, and  
dispensing  
equipment

# H2A Hydrogen Analysis Tool – Case Specific Cost Inputs

## Direct Capital Costs

- Enter production and compression/storage/dispensing costs in appropriate sections unless you have an integrated system (use production section)
- Include as much detail as possible
- Make sure that the total cost is reflected in the “Total Direct Capital Investment (depreciable) \$” cell

# H2A Hydrogen Analysis Tool – Case Specific Cost Inputs

## Replacement Costs

| A                                                                                                         | B                    | C                      | D                                             |
|-----------------------------------------------------------------------------------------------------------|----------------------|------------------------|-----------------------------------------------|
| <b>Unplanned Yearly Replacement Capital (Depreciable)</b>                                                 |                      |                        |                                               |
|                                                                                                           |                      | <b>Comments</b>        | <b>Source</b>                                 |
| Total Unplanned<br>Replacement<br>Capital Cost<br>Factor (% of total<br>direct depreciable<br>costs/year) | 0.00%                |                        |                                               |
|                                                                                                           |                      |                        |                                               |
|                                                                                                           |                      |                        |                                               |
|                                                                                                           |                      |                        |                                               |
|                                                                                                           |                      |                        |                                               |
| <b>Actual Year</b>                                                                                        | <b>Analysis Year</b> | <b>Operations Year</b> | <b>Specified Yearly<br/>Replacement Costs</b> |
|                                                                                                           |                      |                        | <b>Year 2005 \$</b>                           |
| 2005                                                                                                      | 1                    | 1                      |                                               |
| 2006                                                                                                      | 2                    | 2                      |                                               |
| 2007                                                                                                      | 3                    | 3                      |                                               |
| 2008                                                                                                      | 4                    | 4                      |                                               |
| 2009                                                                                                      | 5                    | 5                      |                                               |
| 2010                                                                                                      | 6                    | 6                      | \$193,961                                     |
| 2011                                                                                                      | 7                    | 7                      |                                               |
| 2012                                                                                                      | 8                    | 8                      |                                               |

Unplanned replacement cost factor generates constant yearly costs – Be careful not to double count with maintenance and repair costs on the “Cost Inputs” sheet

Enter major planned  
replacements in the  
appropriate year here – Match  
with Plant Life

# H2A Hydrogen Analysis Tool – Results

- On “Results” sheet, click “Solve cash flow for desired IRR”
- The “Cost Contribution Chart” will be generated automatically
- None of the other charts are generated automatically – The user must enter desired values in the chart table
  - IRR Graph
  - Sensitivity – Tornado
  - Sensitivity – Monte Carlo

# H2A Hydrogen Analysis Tool – Resources

- Download current timeframe cases from:
  - [http://www.hydrogen.energy.gov/h2a\\_production.html](http://www.hydrogen.energy.gov/h2a_production.html)
  - Click on “Assumptions and Ground Rules” for H2A default values and assumptions.
  - Click on “Central and forecourt production technology case studies” to download Excel workbooks. (follow online directions)
- Download the ethanol case study from:
  - <http://www.hydrogenproductionworkinggroupregistration.govtools.us/GateKeeper.aspx?ReturnUrl=%2fDefault.aspx> (during the meeting only).