Moving Toward Consistent Analysis in the HFC&IT Program: *H2A*

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Project ID: AN2

Barriers

Section 4.5 of the Program's RD&D Plan

- B: Lack of consistent data, assumptions, and guidelines
- D: Stovepiped/siloed analytical capabilities

Budget

- Total project funding ~ $1.4M DOE
- FY04 = $600k
  - $350k to National Labs
  - $250k to contractors & universities
- FY05 = $300k
  - $200k to National Labs
  - $100k to contractors & universities

Timeline

- February 2003 start
- Ongoing
  - Supports other elements of Program
  - Production and delivery model development nearly complete

Partners, Interactions, Collaboration

H2A team: **DOE, NREL, Technology Insights, Parsons Engineering, Directed Technologies, Inc., TIAX, ANL, UC Davis, PNNL**

Key Industrial Collaborators: AEP, Air Products, Areva, BOC, BP, ChevronTexaco, Conoco Phillips, Eastman Chemical, Entergy, Exxon Mobil, FERCO, GE, Praxair, Shell, Stuart Energy, Thermochem

Feed to and feedback from: OnLocation, ORNL, ANL, DOE PBA, DOE FE, DOE NE, LLNL Markal, EPA

Objectives

- Overall goal: Bring consistency and transparency to hydrogen analysis
- Phase I goals:
  - Production analysis
  - Consistent cost methodology & critical cost analyses
  - R&D portfolio analysis
  - Tool for providing R&D direction

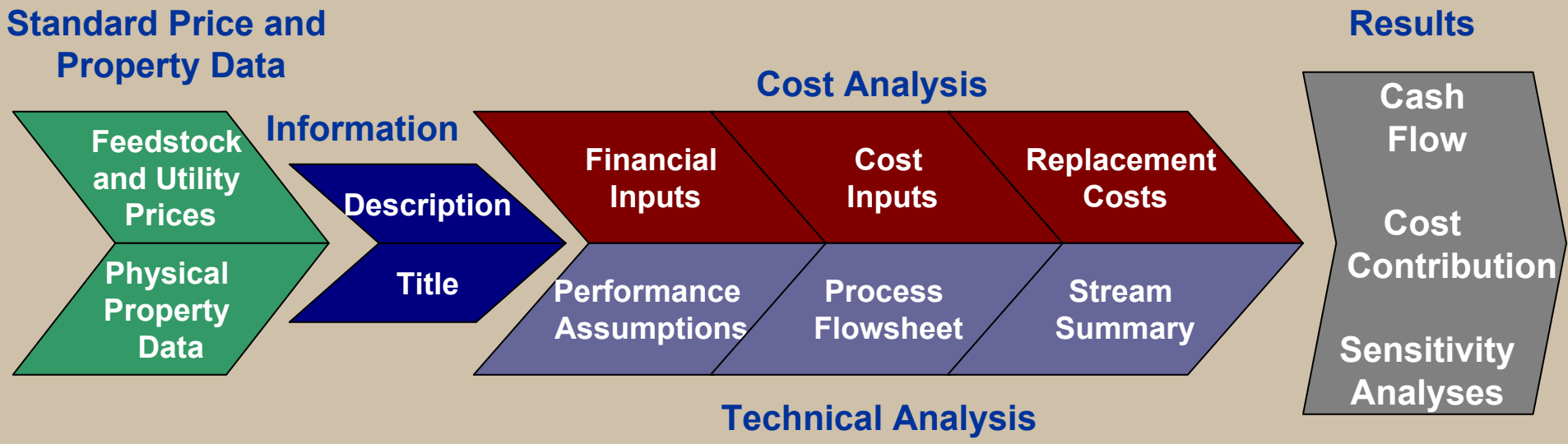
Approach

- Cash flow analysis tool
  - Consistent approach for calculating selling price of hydrogen
  - Template for reporting analysis assumptions
- Test analysis tool
- Study key technologies
- Identify key cost drivers using sensitivity analyses

Technical Accomplishments

- Version 1.0 of cash flow model complete
- Beta testing of v1.0
- Hydrogen selling price estimated for key technologies
  - Current, mid- (~2015), and long-term (~2030) technologies
  - Natural gas, coal, biomass, nuclear, electrolysis
- Beginning to apply H2A to other areas
  - Storage
  - Fuel cells

H2A Production Cash Flow Analysis Tool



- Discounted cash flow rate of return analysis
- Provides the levelized selling price of hydrogen required to attain a specified internal rate of return
  - i.e., minimum hydrogen price
- Model is meant to be a means of *reporting* assumptions as well as *calculating* hydrogen selling price
- Transparency is absolute and assumptions are easy to obtain

Core Calculation

$$NPV = \sum_{j=1}^{n} \frac{cashflow_j}{(1+IRR)^j}$$

n = project lifetime, years
j = year of operation

H2A default = 10%

Cash flow (j) = income – capital expenses – debt payments – working capital – labor costs – operating costs – feedstock costs + byproduct credit – depreciation – taxes

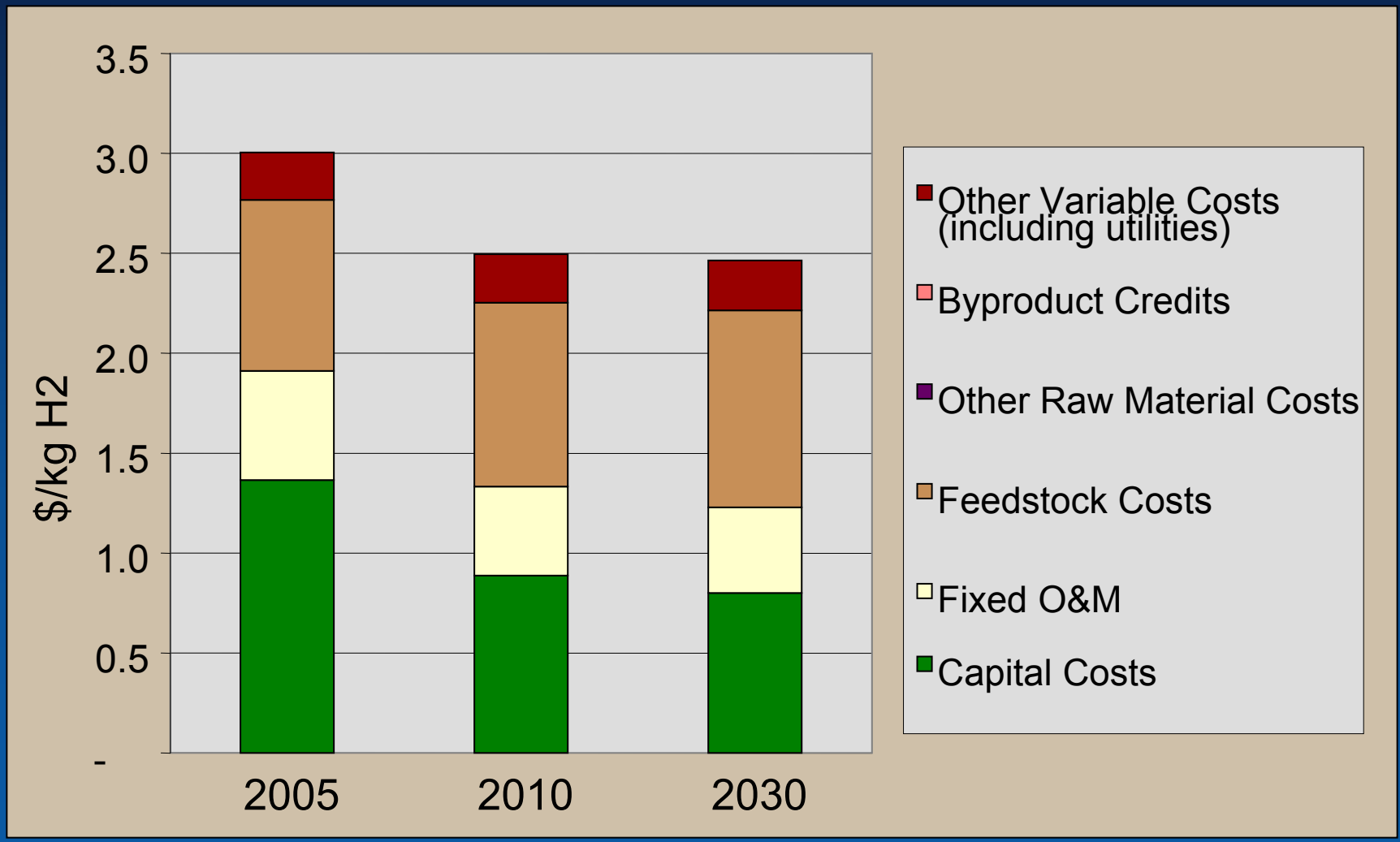
Income (j) = $\frac{\$/kg_{H2}}{kg_{H2}/year}$

Model seeks selling price of hydrogen that sets NPV to zero

Beta Test of v 1.0

- Asked reviewers:
  - Are the H2A financial guidelines reasonable?
  - Are the calculations correct?
  - Do you have recommendations for enhancements?
  - Is the model easy to use?
  - Provide details on errors and comments
- 175 comments from fifteen reviewers
- Comment severity:
  - 1: Model does not work or issue contradicts stated goals of H2A (zero received)
  - 2: Possible functionality error (23 received)
  - 3: Recommended formatting or enhancement (138 received)

Technical Accomplishments: Example Case Study



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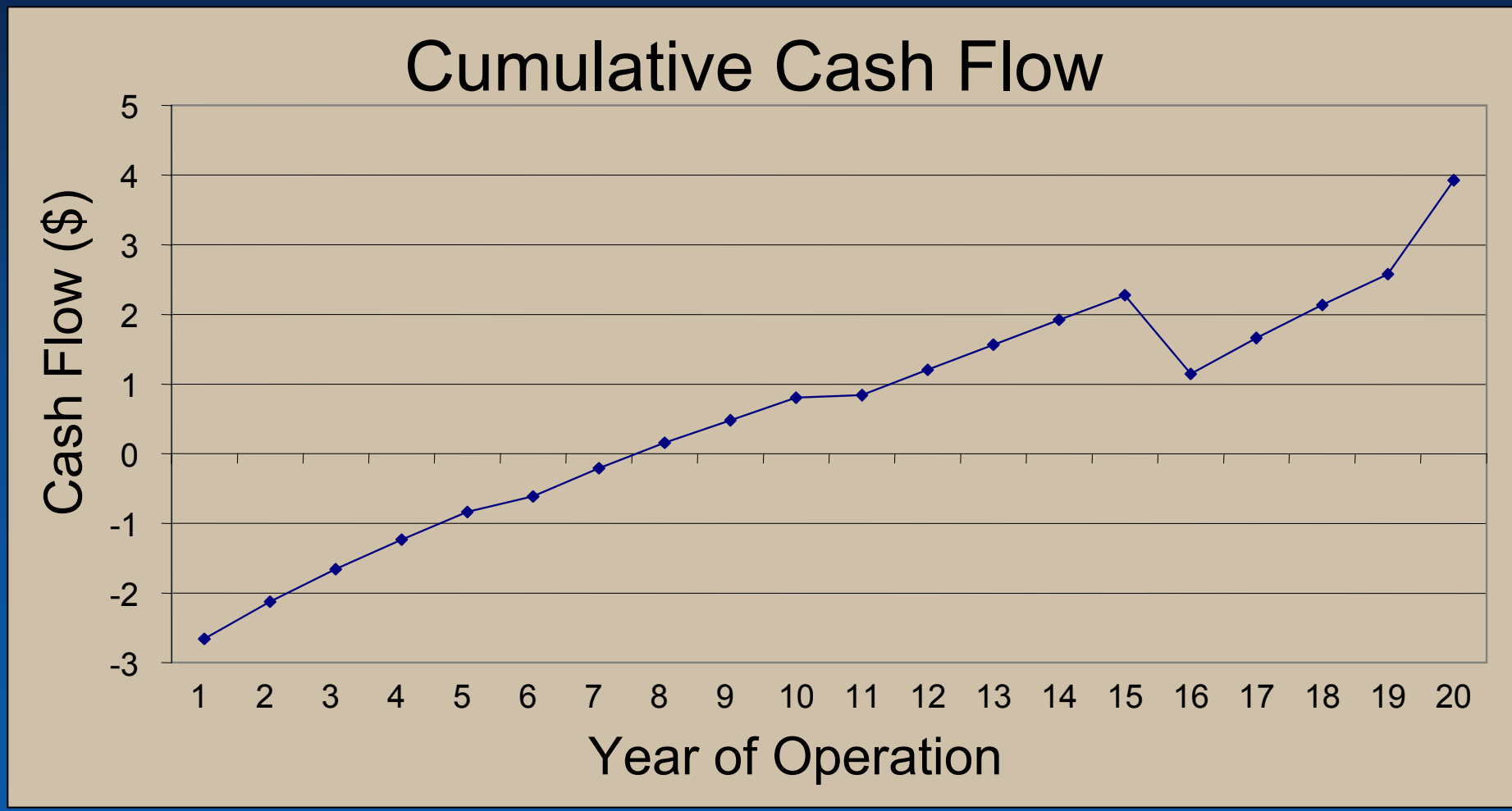
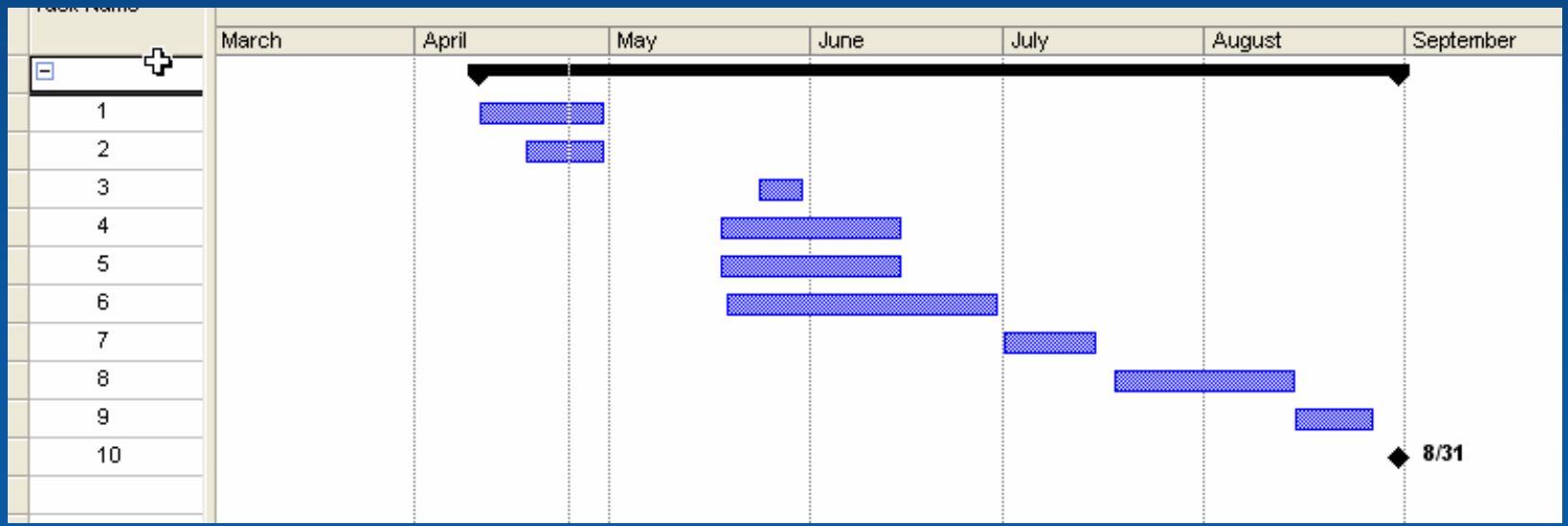


Version 2.0

1. Add CRF and fixed-charge rate calcs
2. Provide for scaling of equipment
3. Identify options for automating Monte Carlo
4. Automate efficiency calcs via feedstock and utility consumption
5. Automate CO_2 emissions via feedstock consumption
6. Create an automatic link to GREET
7. Modified documentation to reflect all changes made
8. Test version 2.0 of model and receive comments
9. Make critical changes to model
10. Deliver completed version 2.0 to DOE



Status

- H2A model coordinates with delivered hydrogen cost range
- Capital recovery factor and fixed charged rate calculations included for comparison
- Scaling calculations implemented
- Efficiency calculations, CO_2 emissions calculations, and GREET link underway

Future Work: Other Areas

- Apply principles of H2A (consistency and transparency) to other areas of analysis
- Fuel cells, storage
- Provide H2A model for other analysis work (ORNL, ANL, NREL, EIA/OnLocation NEMS)
- Use H2A model in tech validation projects

Publications & Presentations

- Presentation to the National Academy of Sciences Panel on Hydrogen
- Presentations at the Annual National Hydrogen Association Meeting
- Documentation of central and forecourt modeling tools

Project Safety

- Effort aimed at determining cost of hydrogen
- Plant design costs inherently include safe design and safe operation
- Provide relevant codes & standards data as they are developed
- Hydrogen quality (composition) integration across pathways