DOE Hydrogen Program

Adapting the H2A Hydrogen Production Cost Analysis Model to Stationary Applications

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Project ID: ANP1

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Overview

Timeline		Barriers
Project start date	– January 2008	**Section 4.5 of the Program's RD&D Plan** **B:** Stovepiped/siloed analytical capabilities **C:** Lack of consistent data, assumptions, and guidelines **E:** Unplanned Studies and Analysis
Project end date	– H2A Stationary Model v1.0 September 2008	
Percent complete	– 60%	

Budget	Partners
Total project funding $130K to NREL **Funding received in FY07** $0 **Funding for FY08** $128K	**H2A Team:** DOE, NREL Directed Technologies, Inc. **Partners/Reviewers:** DOE FE Battelle, Fuel Cell Energy, UTC, Plug Power, LOGANEnergy Risø National Laboratory (Denmark)

Objectives

Expand the capabilities of the H2A model to evaluate stationary production of:

- Electrical power
- Heat co-generation
- Hydrogen co-generation

The H2A Mission

Improve the transparency and consistency of cost analysis, improve the understanding of the differences among analyses, and seek better validation from industry.

The H2A model aims to make analyses:

- **Consistent**
- **Transparent**
- **Comparable**

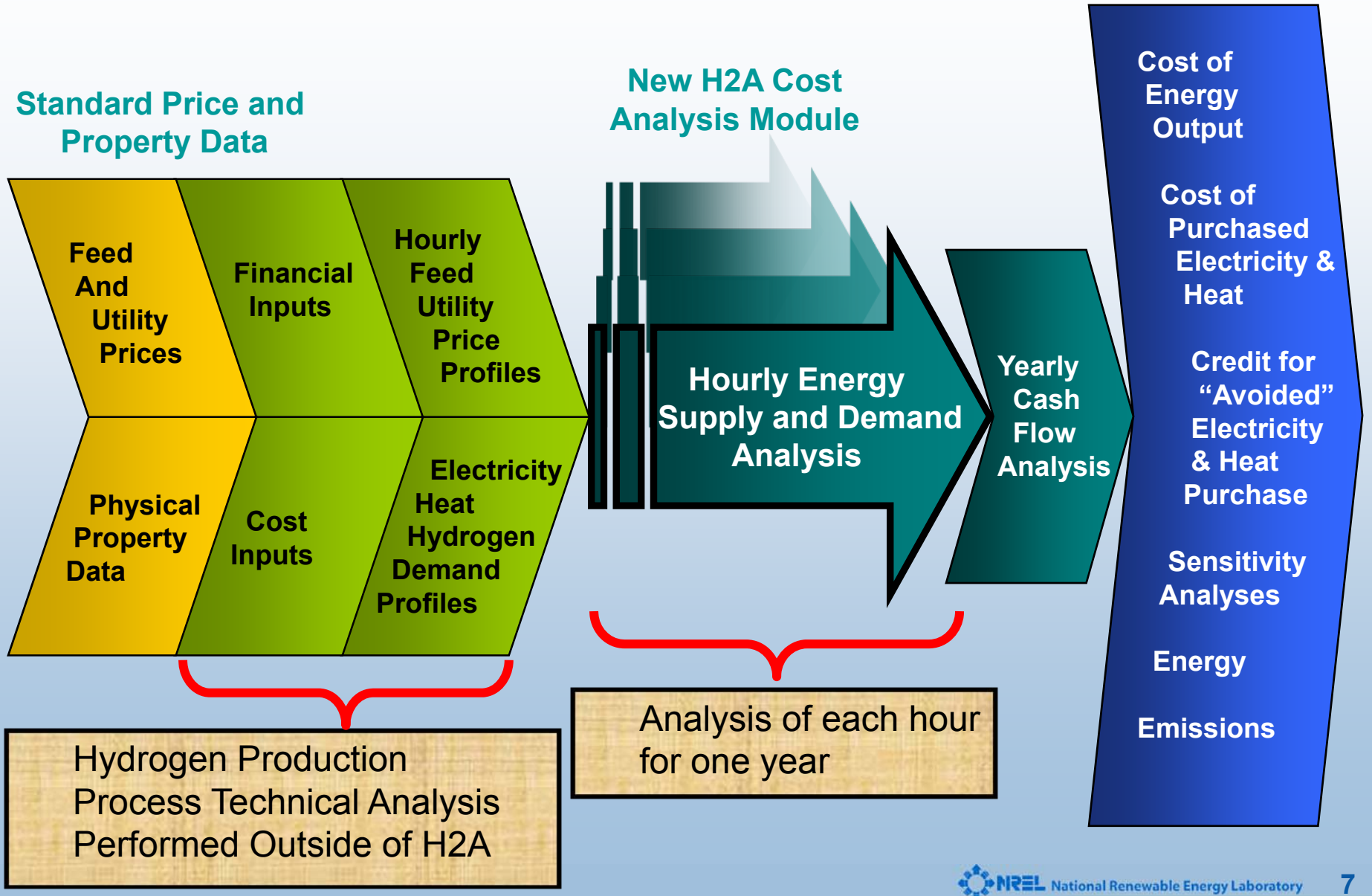
Milestones

Month / Year	Milestone
3/08	1) Meet with industry partners
6/08	2) Incorporate industry feedback
8/08	3) Draft H2A Stationary Model Version 1.0 Complete
9/08	4) Final version 1.0 of H2A stationary model complete

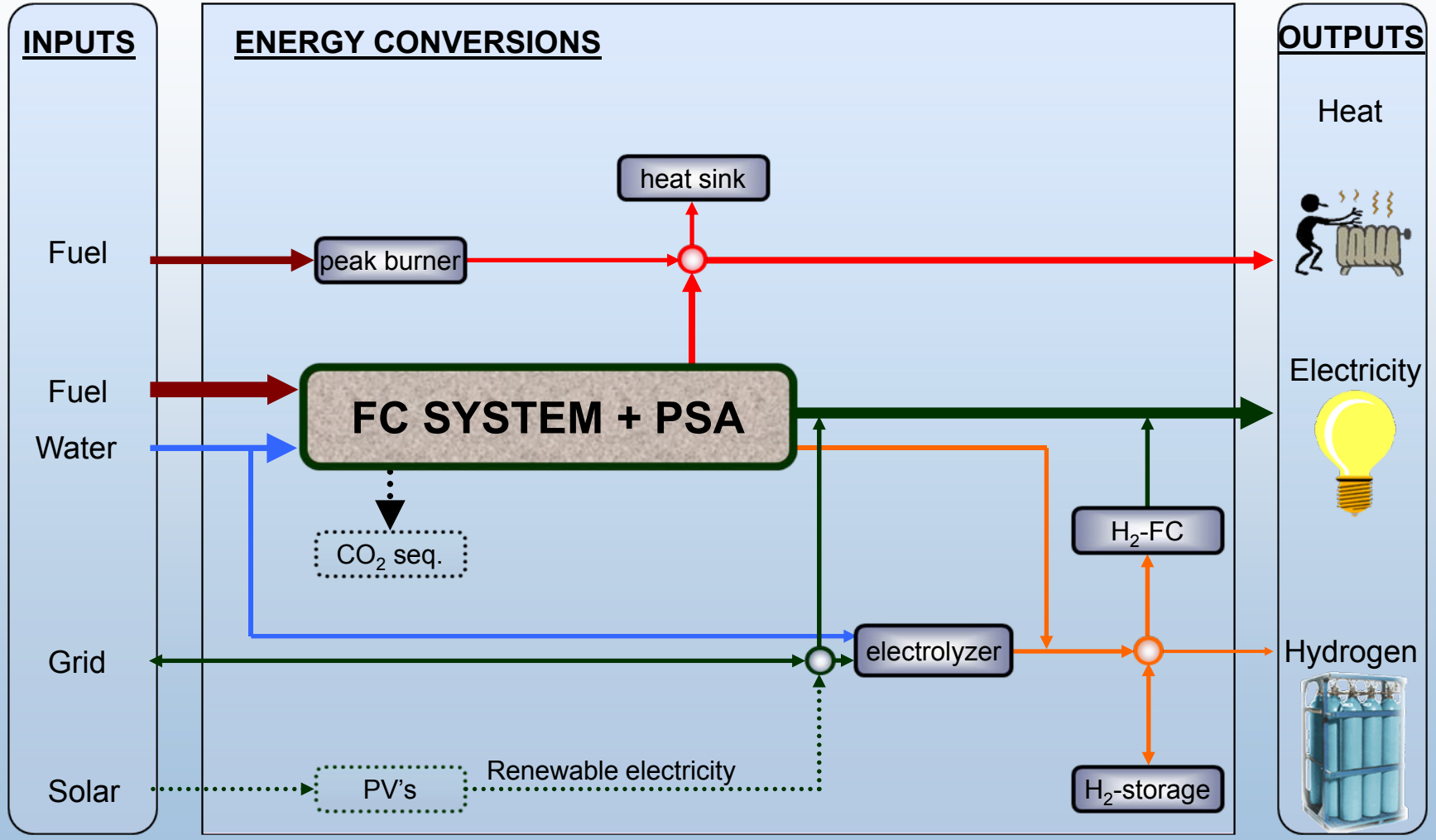
Technical Approach Tasks

Task	Description
1	Develop model of hourly energy use. Refine model based on industry and partner feedback (Milestones 1 and 2)
2	Develop and implement energy demand profile input strategy and equipment cost and performance input sheets. Refine input strategy based on industry and partner feedback (Milestones 1 and 2)
3	Integrate task 1 and 2 outputs into H2A model structure and cash flow analysis (Milestone 3)
4	Review and refine version 1 of H2A life-cycle analysis model for stationary applications (Milestone 4)

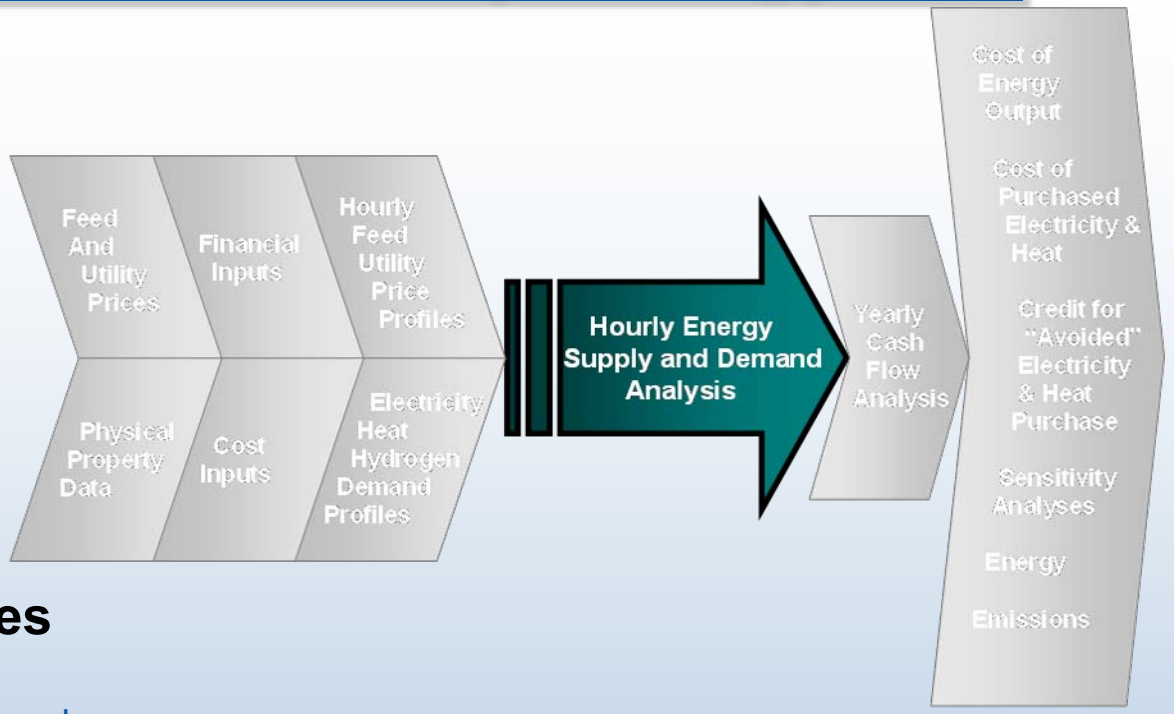
Technical Approach



Task 1 – Model of Hourly Energy Use



Task 1 – Model of Hourly Energy Use



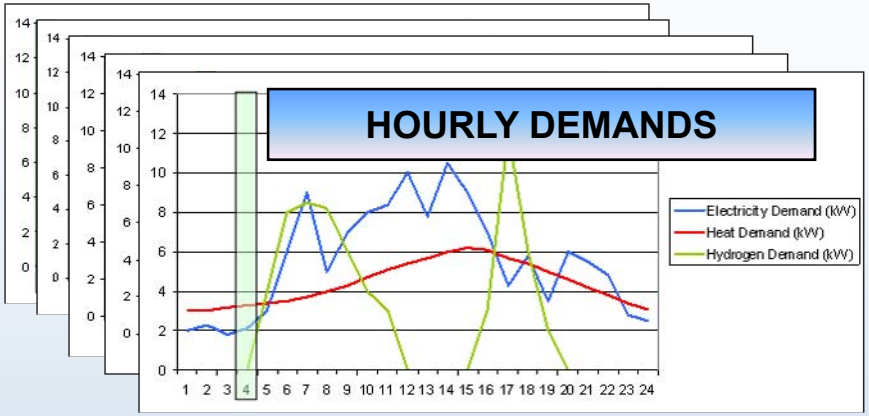
Prioritize Energy Sources

- Renewable sources tapped first
- Minimal power outputs used second
- Additional needs met with additional capacity
- Grid balances excess demand and supply

Total Resulting Annual Energy Flows

- Fraction of demand supplied by each technology
- Sum hourly AC supplied
- Sum hourly heat supplied
- Sum hourly hydrogen supplied
- Sum hourly fuel consumption
- Sum hourly water consumption

Task 2 – Develop input strategy for demand profiles equipment variables and costs

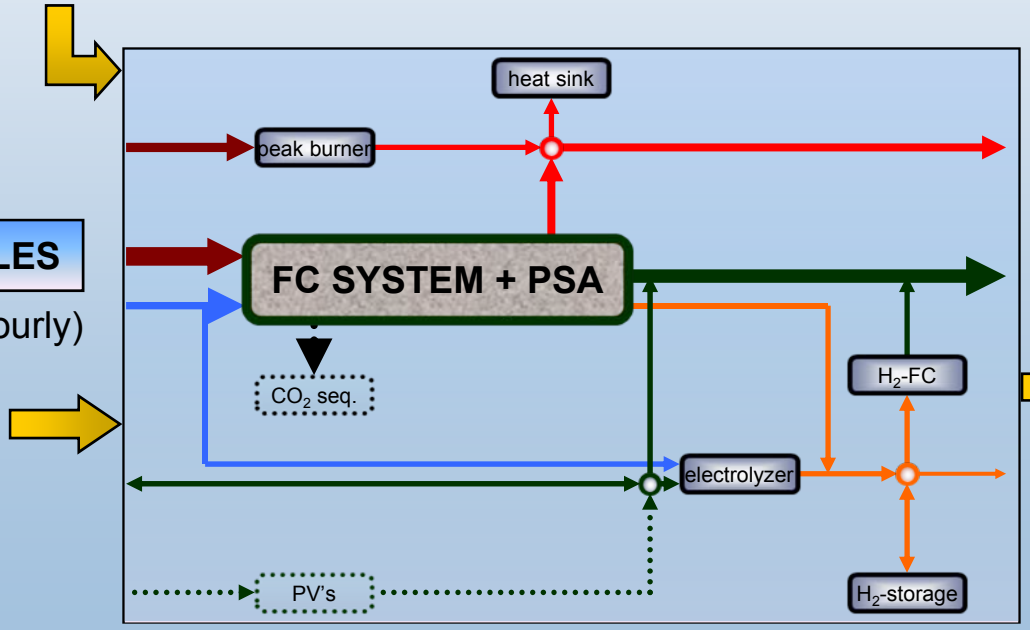


Enter Process Specifications (default values will be provided)

- Download or enter hourly demand profiles
- Download or enter hourly renewable energy profiles
- Enter grid electricity price profile (peaking price structure)
- Enter equipment capital costs
- Enter equipment capacity, operating parameters and operating costs

PRICE SCHEDULES

- Grid electricity (hourly)
- Fuel prices
- Water price



ENERGY FLOWS ($)

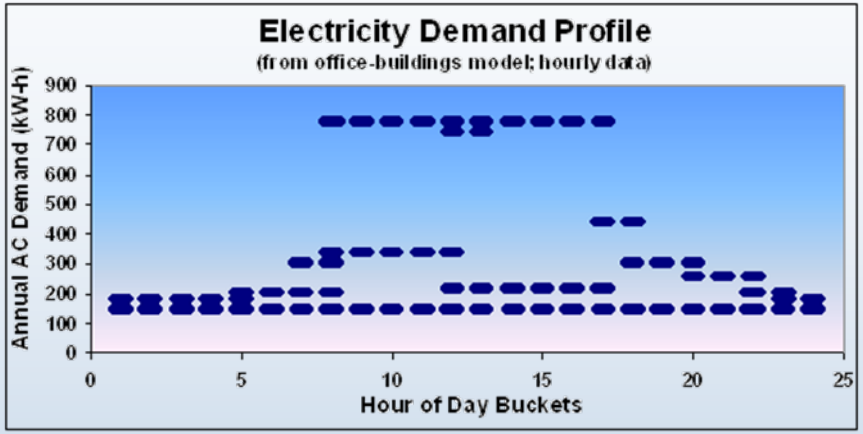
- Delivered electricity
- Delivered heat
- Delivered hydrogen
- Used fuel
- Used grid electricity
- Sales to grid

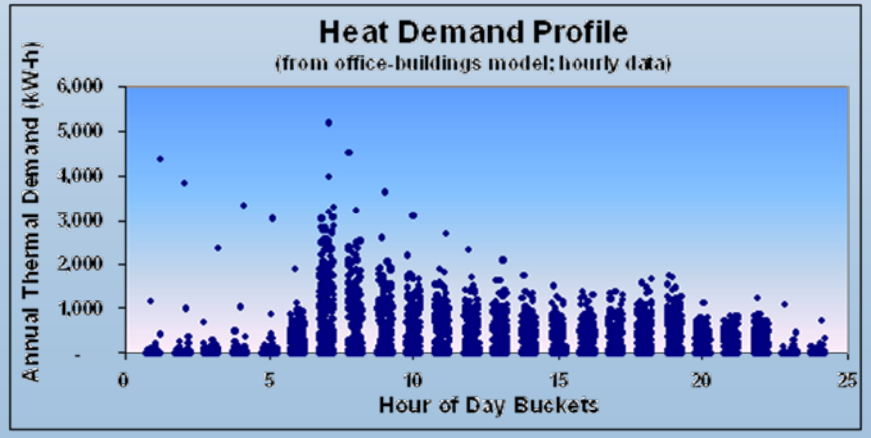
Task 2 – Example Input Profiles

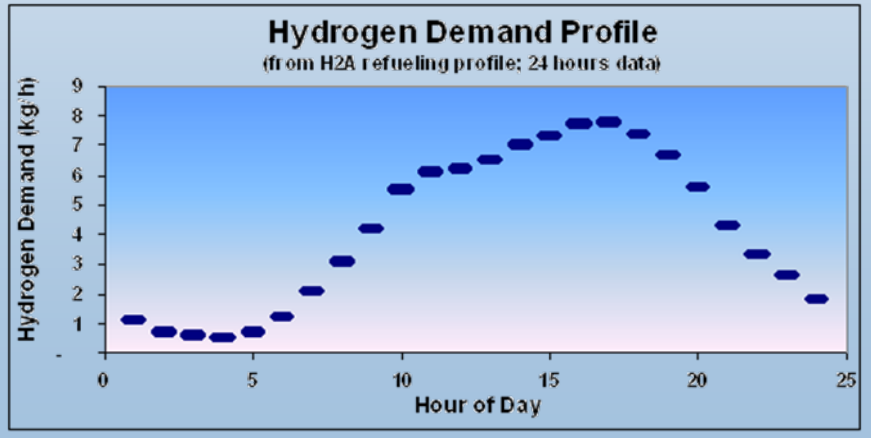
EXAMPLE YEARLY DEMANDS

Demand	Quantity	Units
Electricity	3.1	Million kW-h/year
Heat	1.6	Million kW-h/year
Hydrogen	100	kg/day

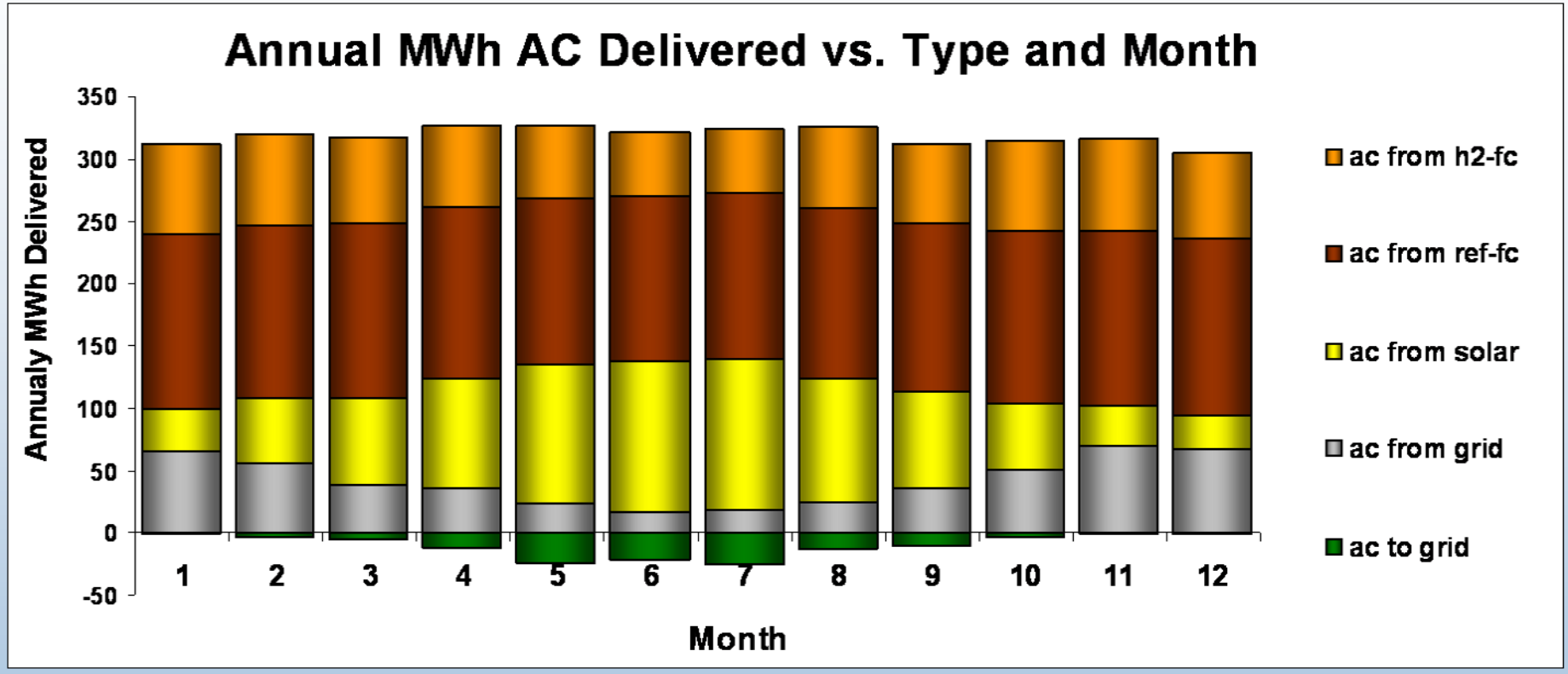
Representative profiles will be available online or can be user-specified.





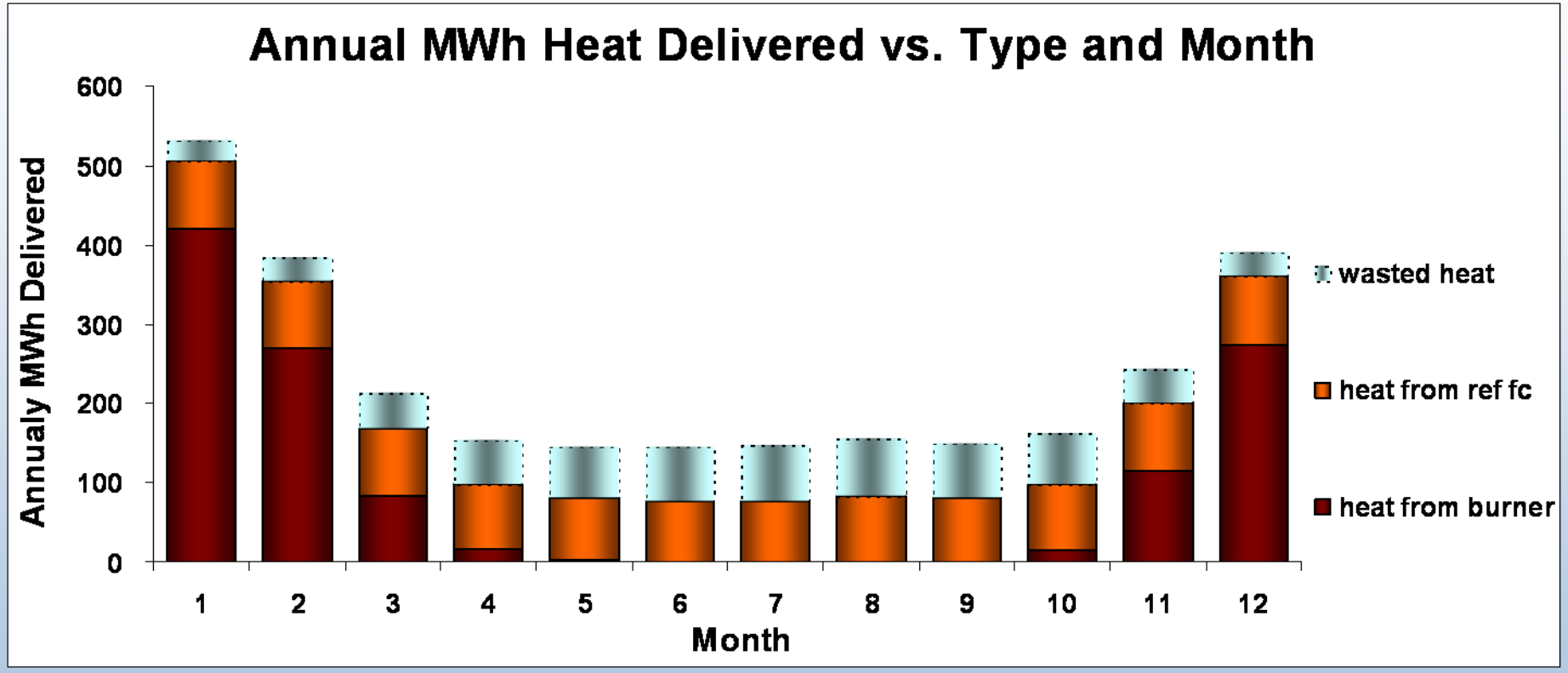


Task 2 – Example Annual AC Supply Profile



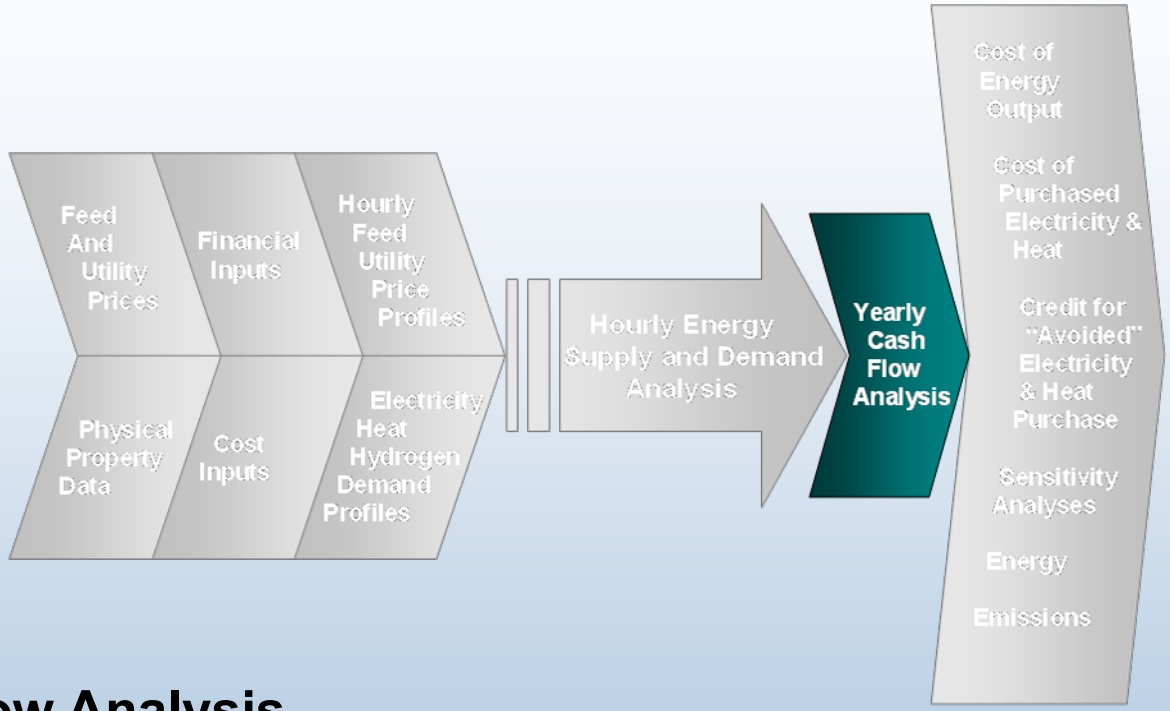
Visualization of results shows energy source types to satisfy total AC demand.

Task 2 – Example Annual Heat Supply Profile



Visualization of results shows demand supplied and heat wasted (cooling tower).

Task 3 – Integrate Values from Tasks 1 and 2 into H2A Cash Flow Analysis



H2A Cash Flow Analysis
(lifetime summary of costs and revenue)

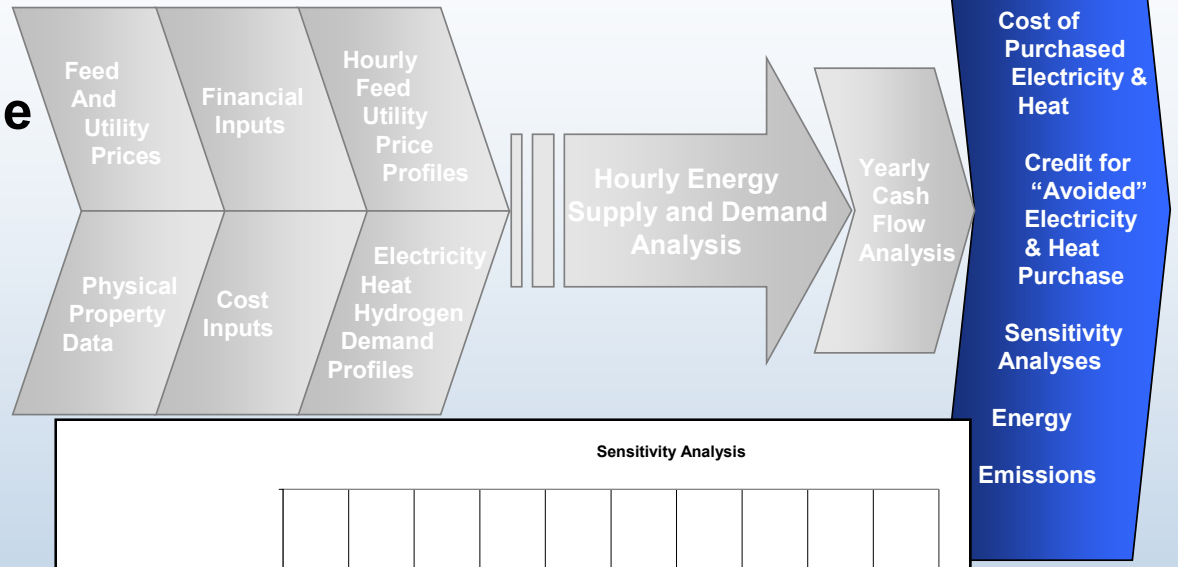
- Yearly summary feed and grid electricity costs and "revenue" from electricity, heat, and hydrogen produced used in H2A cash flow calculations

- Capital, operating, replacement costs and financial parameters (specified in Step 1) used in H2A cash flow calculations

Task 4 – H2A life-cycle analysis

(cost, energy and emissions results)

H2A standard analysis interfaces will be available as well as sensitivity analysis of results.



COST RESULTS

Specific Item Cost Calculation

Cost Component	Cost Contribution ($/kg)	Percentage of H2 Cost
Capital Costs	$0.790	34.0%
Decommissioning Costs	$0.001	0.0%
Fixed O&M	$0.292	12.6%
Feedstock Costs	$0.585	25.2%
Other Raw Material Costs	$0.463	19.9%
Byproduct Credits	$0.000	0.0%
Other Variable Costs (including utilities)	$0.192	8.3%
Total	$2.323	

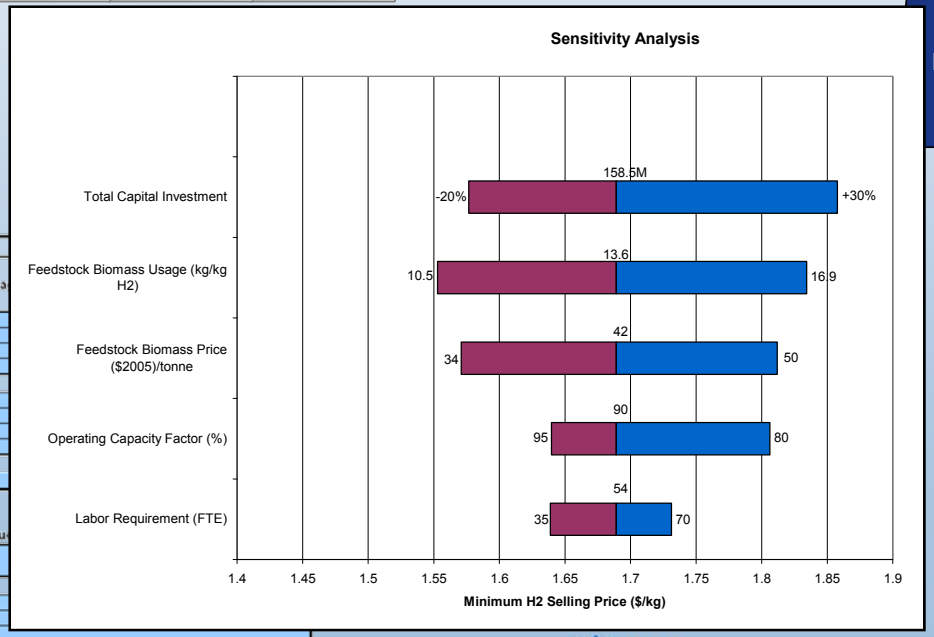
ENERGY

Energy Data

Feedstock	Energy Input (GJ/kg H2)	Energy Input (kWh/kg H2)	LHV (GJ or mmBtu/usage unit)	Usa
2012 Biomass Target_metric	0.267	74.066	0.020	
Utility				
Commercial Natural Gas_metric	0.006	1.729	0.037	
Industrial Electricity_metric	0.006	1.600	0.004	
Carbon Sequestration				

	Energy Output (GJ/kg H2)	Energy Output (kWh/kg H2)	LHV (GJ or mmBtu/usage unit)	Produ
Hydrogen (1 kg)	0.120	33.329	0.120	
Byproducts				

Results / Cash Flow Analysis / Tornado Chart / Sensitivity_Analysis / Energy Feed & Utility Prices / Non-Energy Material Prices / AEO Data / HyARC Physical Property Data / Debt Financing



Future Work

The H2A Stationary Model will be used in FY09 for cost and energy analyses of a wide variety of stationary applications for production of hydrogen, heat, and electricity. The model will continue to be enhanced to facilitate these analyses.

Summary

The H2A stationary analysis tool provides the flexibility needed to evaluate many potential configurations while maintaining the consistency and transparency of the H2A production analysis tool.