Macro-System Model

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This presentation does not contain any proprietary or confidential information

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Overview

Timeline

- Start date: Feb 2005
- Completion: Sept 2010
- Percent complete: 15%

Budget

- Total funding:
  - 100% DOE funded
- FY05 funding:
  - $170K NREL/SIO
  - $50K Sandia NL
- FY06 funding
  - $276K NREL/SIO
  - $280K Sandia NL
  - $60K other national lab work

Barriers

- Lack of consistent data, assumptions and guidelines (B)
- Lack of a Macro-System Model (C)
- Stove-piped/siloed analytical capabilities (D)

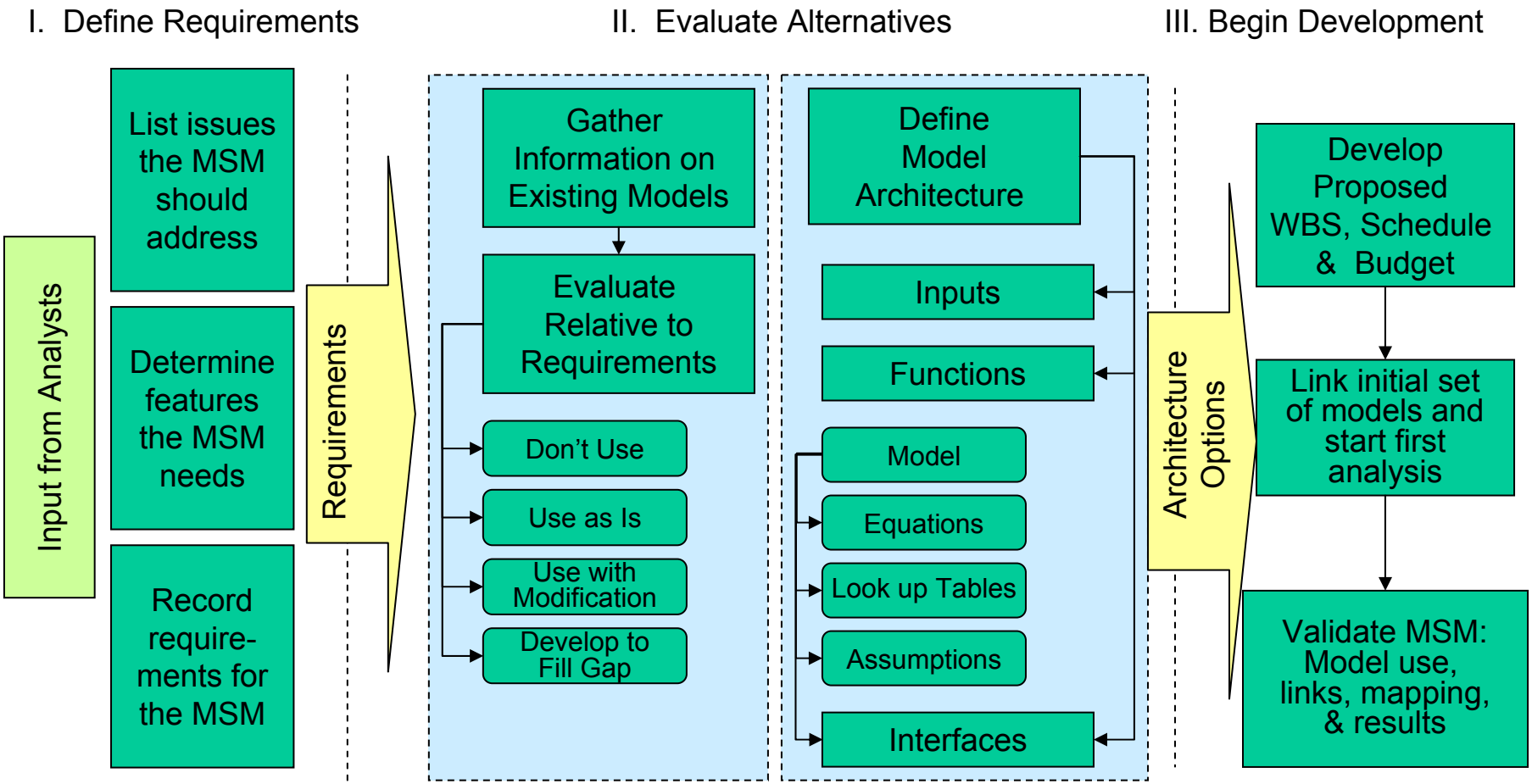
Partners

- Sandia National Laboratory (computational development)
- NREL (inclusion of H2A Production & well-to-wheel analysis validation)
- ANL (inclusion of HDSAM & GREET & well-to-wheel analysis validation)
- Others to be identified

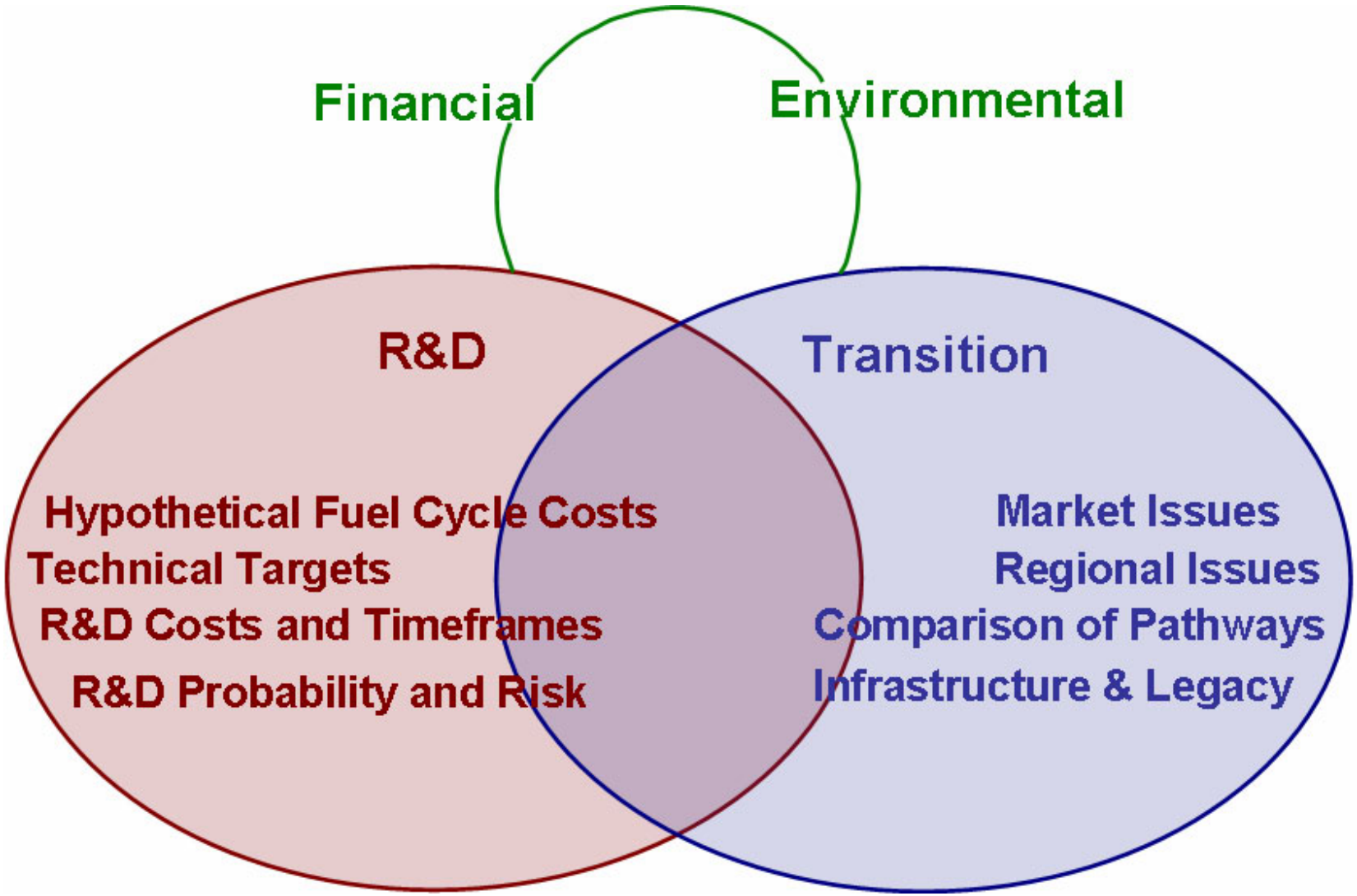
Project Objectives

- **Overall objectives**
  - **Develop a macro-system model (MSM) aimed at**
    - **Performing rapid cross-cutting analysis**
      - **Utilize and link other models**
      - **Improve consistency between models**
    - **Supporting decisions regarding programmatic investments and focus of funding**
    - **Supporting estimates of program outputs and outcomes**
- **2005/2006 objectives**
  - **Define analysis issues / model requirements**
  - **Evaluate alternatives for the MSM structure and select an approach for development**
  - **Initial integration of models**
  - **Initial analysis: Comparison of hydrogen production/delivery pathways**
  - **Begin validation**

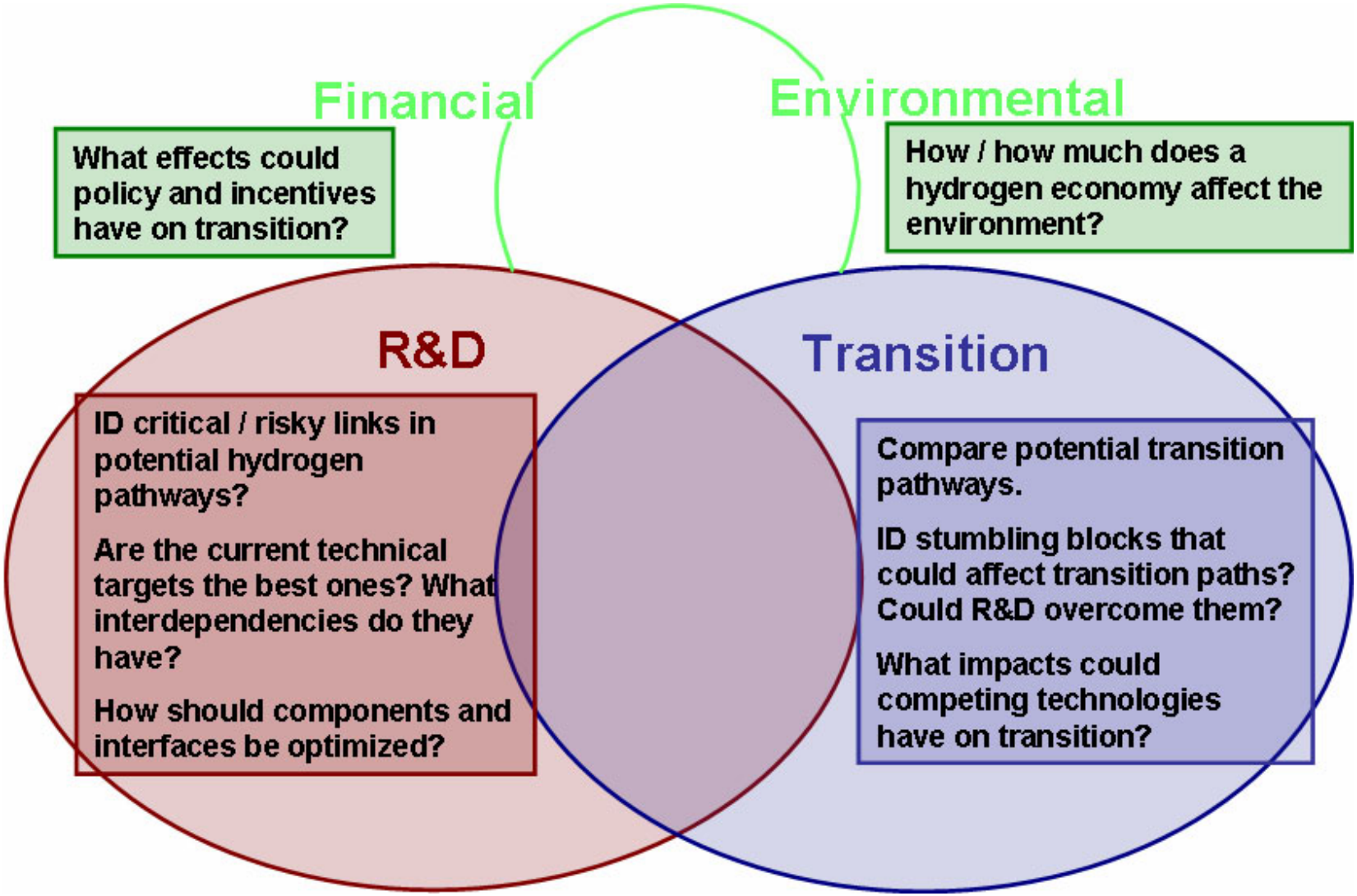
MSM Development Approach



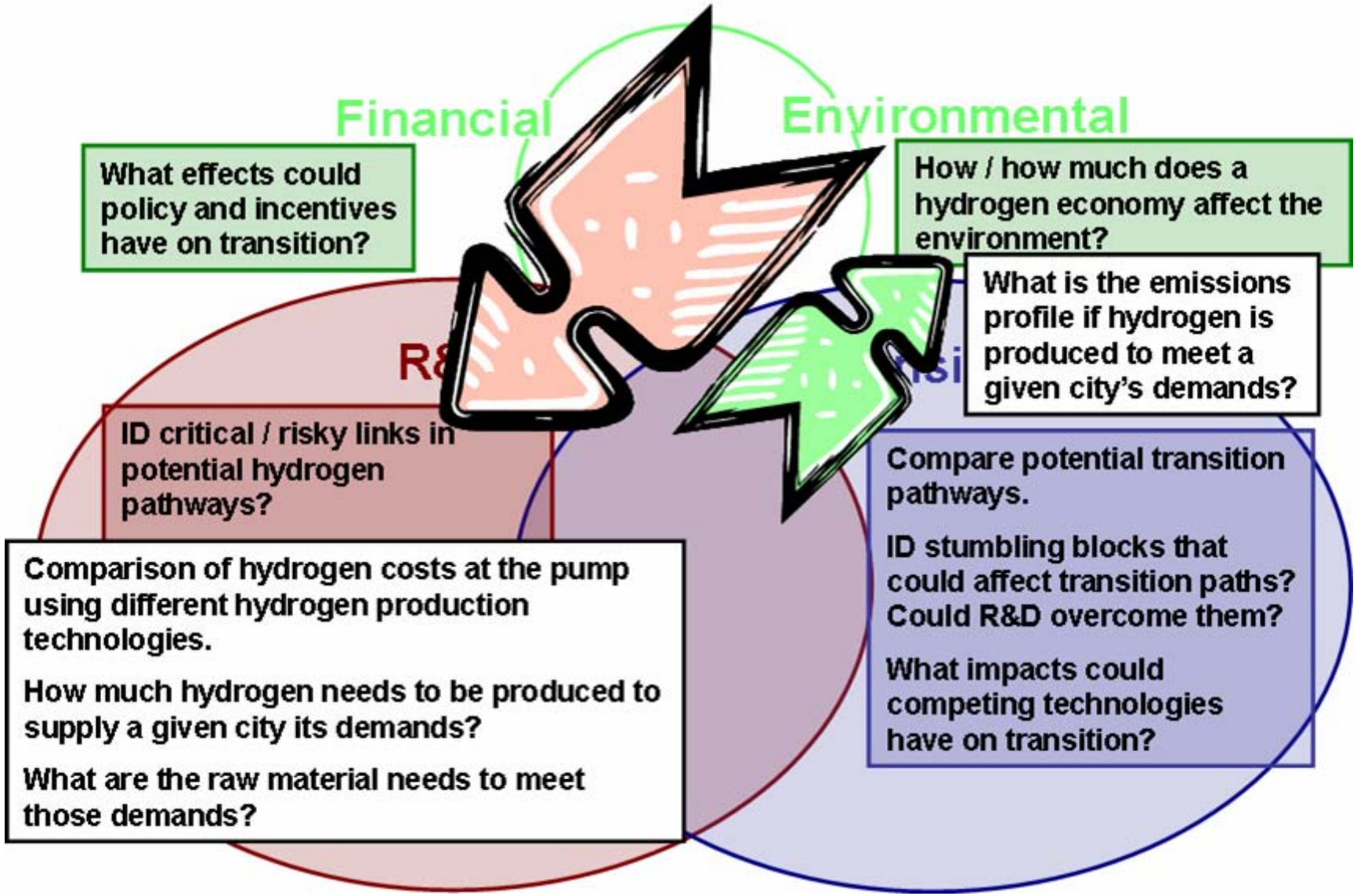
Progress: Analysis Issue Categories



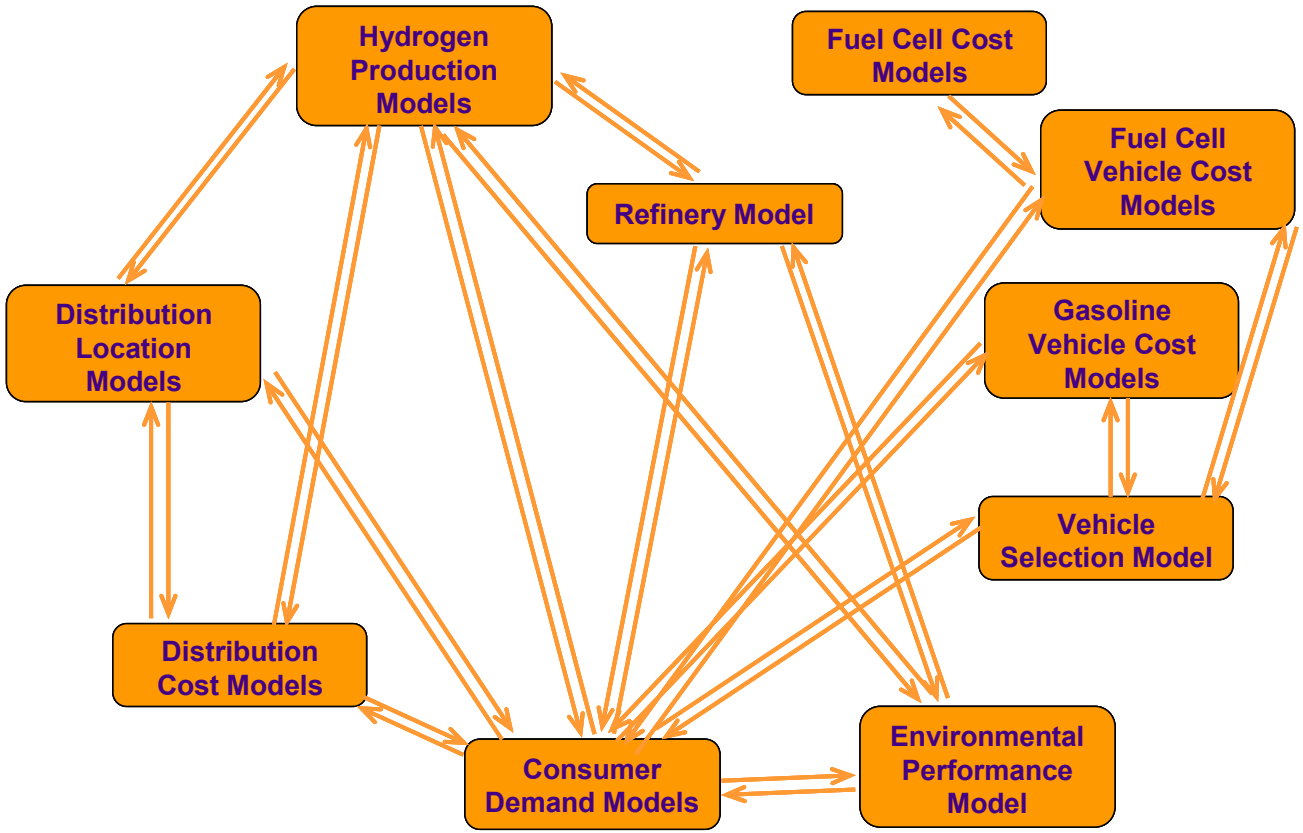
Progress: High Priority Issues



Progress: Initial Analysis Issues



Progress: Evaluation of Alternatives

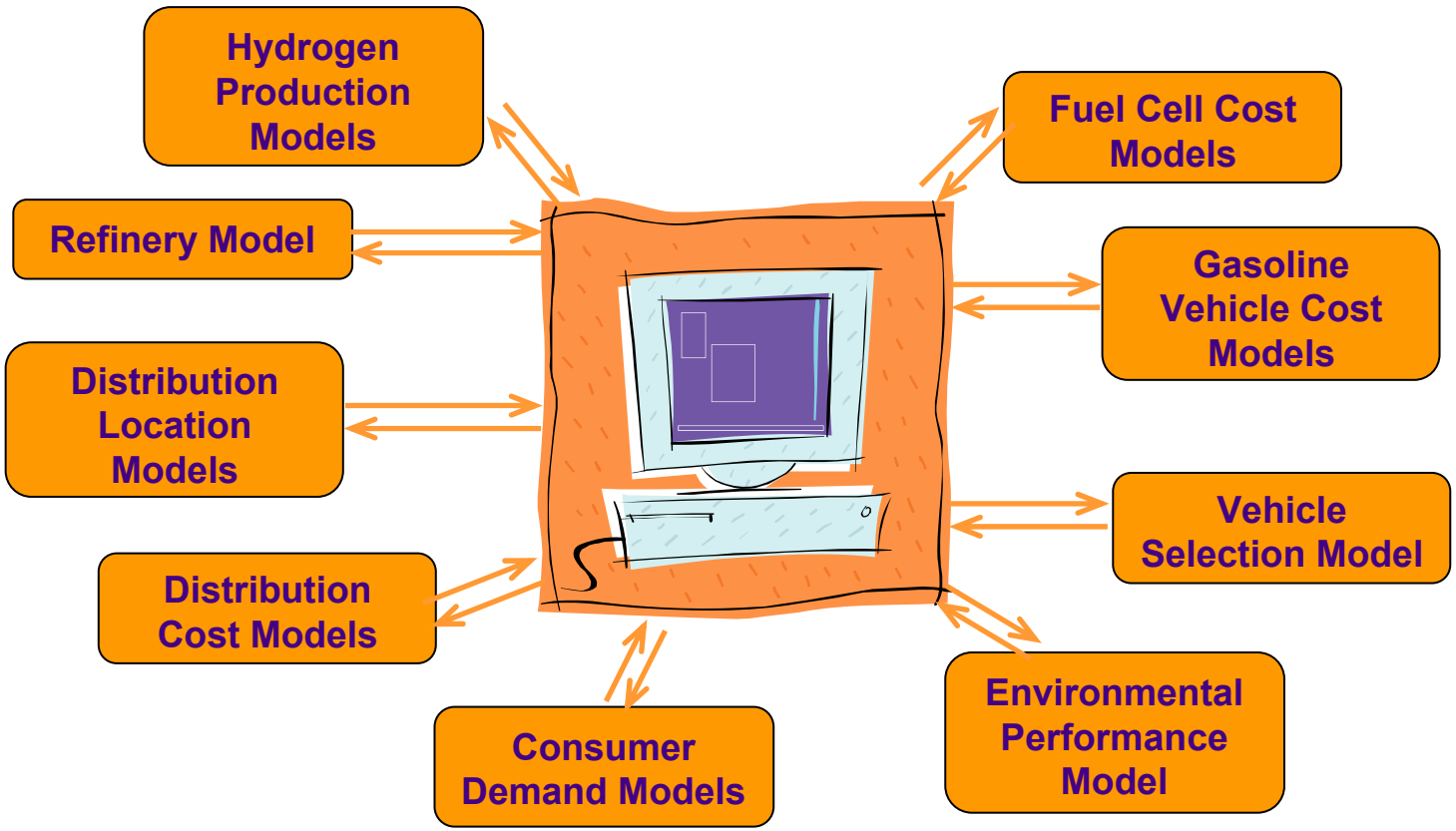


- Option 1: A new model could be built that captures information from all other models and the interactions between them
- Option 2: Model interactions could be defined and interfaces between them could be built

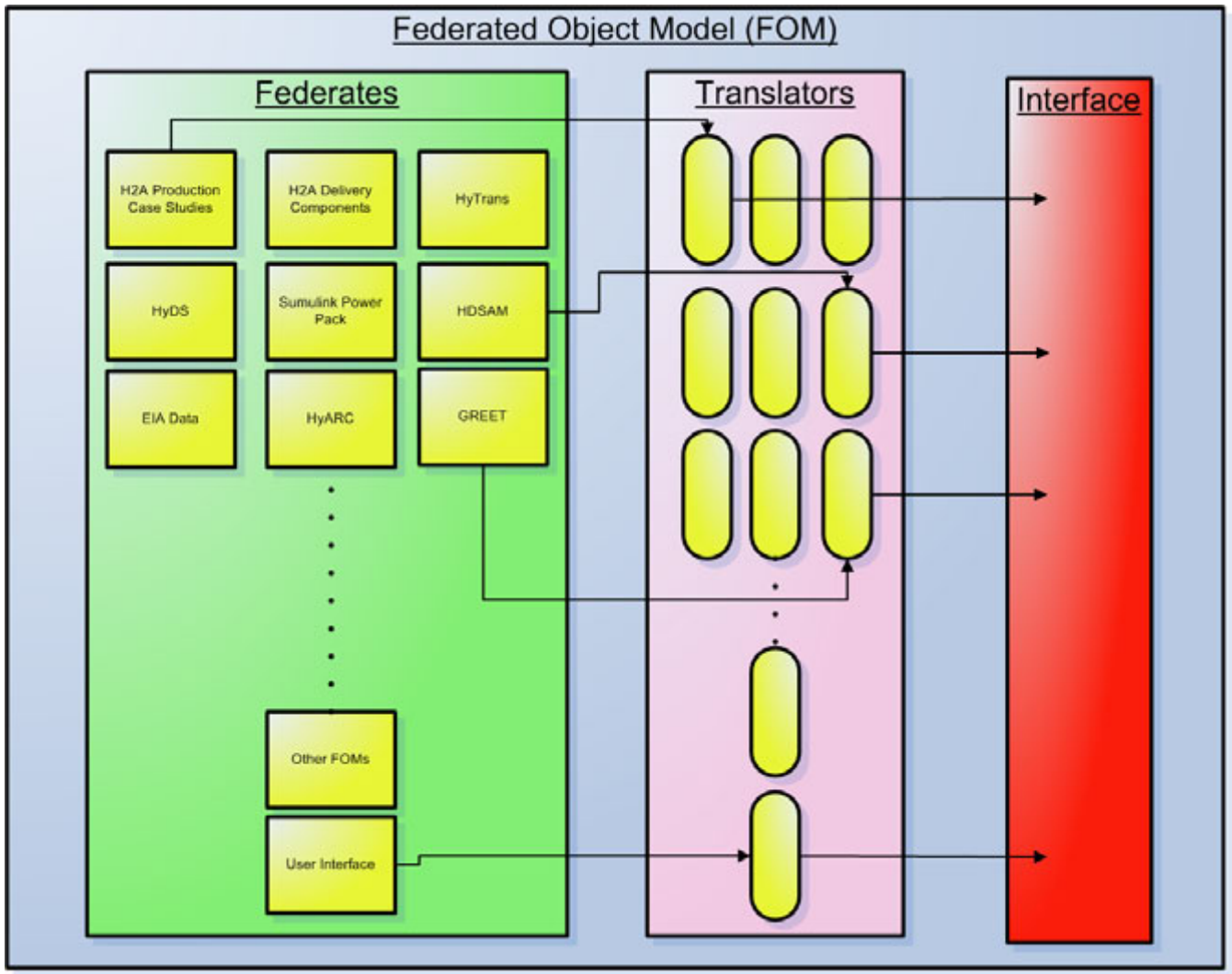
Progress: Selected MSM Approach

Federated Object Model (FOM) – capable of integrating and utilizing existing and emerging component models (federates) to the extent possible

Standard inputs, credible / documented data, and outputs can be shared between models utilizing a single interface



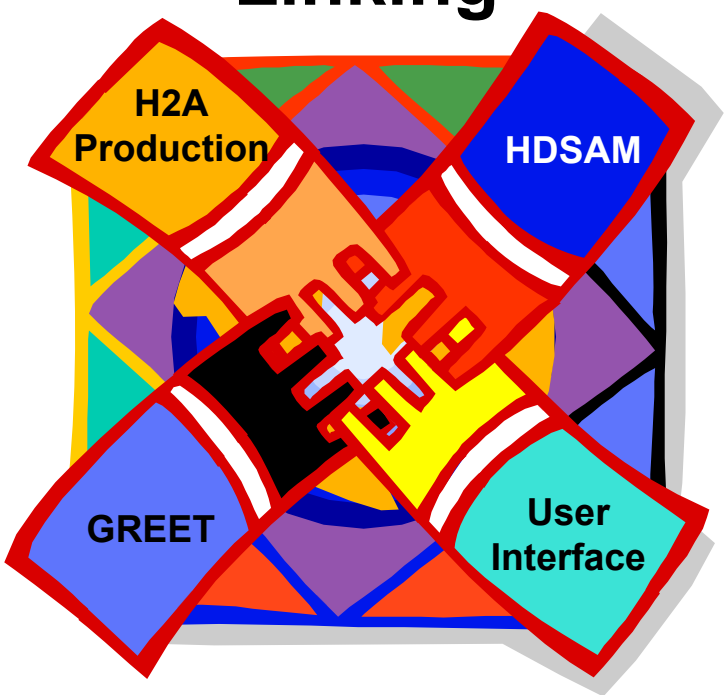
FOM Architecture



- Translators and interface currently in a single Excel workbook
- Java/COM is used to transfer information into translators

Progress: Initial Model Integration

Currently Linking

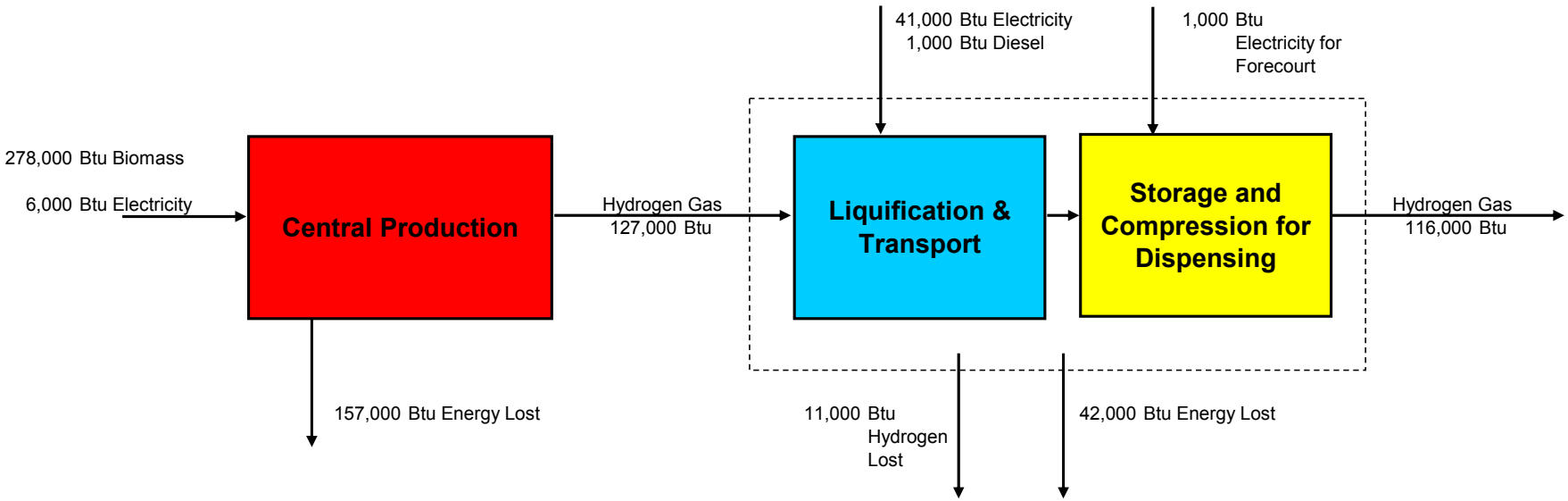


- Information that needs to be transferred has been identified
- A linking interface has been developed in Excel
- Sandia has developed a Java/COM application to transfer data between the linking spreadsheet and the models
- The Java/COM application also launches VBA macros in models
- Links are being reviewed by model developers

Preliminary Results

Pathway Well-to-Wheels

Hydrogen Produced In Central Plant and Transported as Liquid via Truck



Well-to-Wheels Total Energy Use (Btu/mile)	7,133
Well-to-Wheels Petroleum Energy Use (Btu/mile)	206
Well-to-Wheels Greenhouse Gas Emissions (g/mile)	-5
Profited Cost of H2 at Pump ($/GGE)	5.23

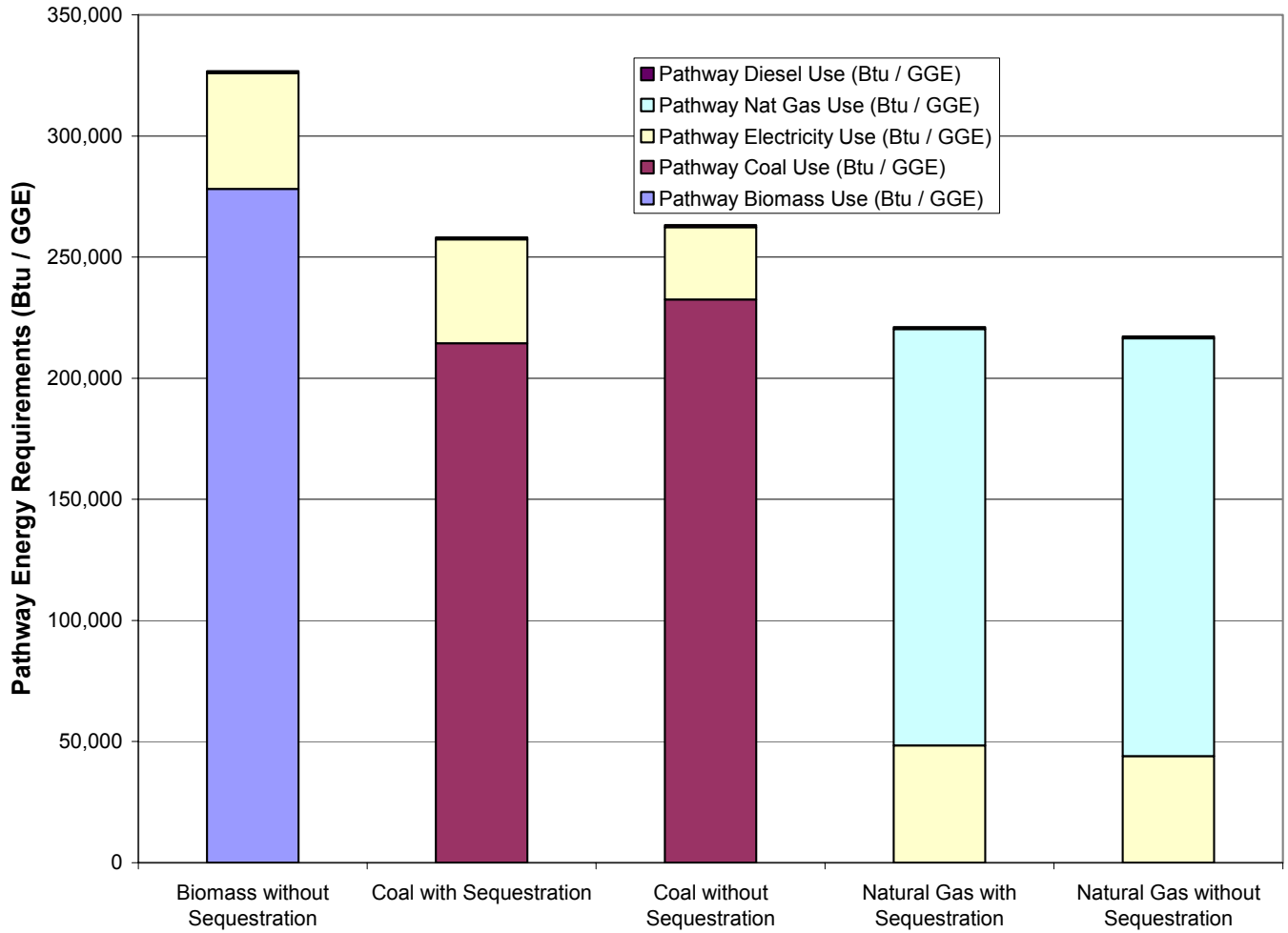
Production Process Energy Efficiency	45%
Pathway Efficiency	35%
WTP Emissions (g CO2 Equivalent / GGE fuel available):	-1

Case Definition
Year: 2005
Hydrogen as Liquid
Central Production
Woody Biomass Feedstock
Sequestration: No
Transport for Delivery: Truck

Do not cite: Results shown are preliminary and require validation/correction. They are only intended to be examples of the type of results the MSM will generate.

Preliminary Results

Energy Sources for Hydrogen Pathways



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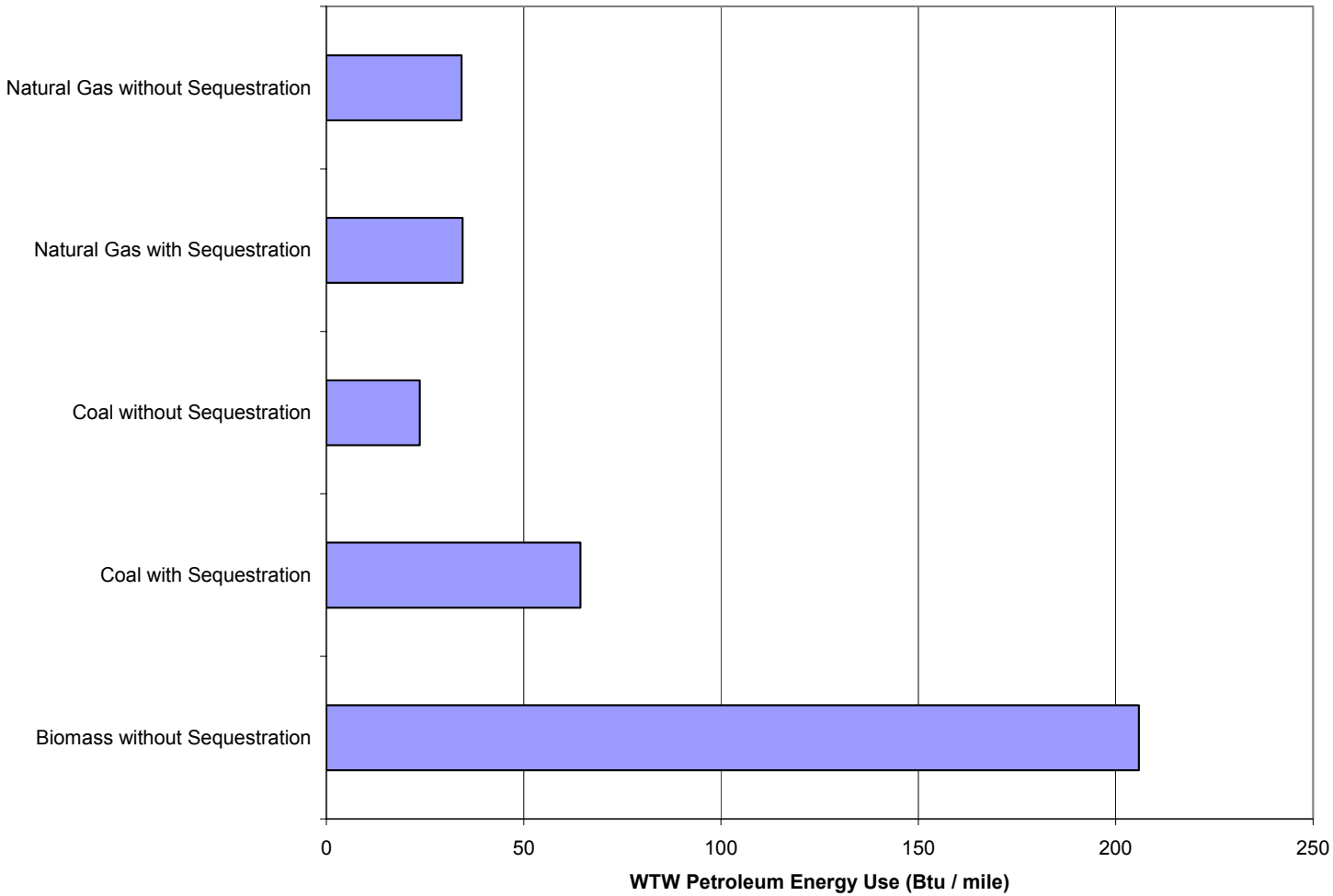
Preliminary Results

Petroleum Requirements for H2 Pathways



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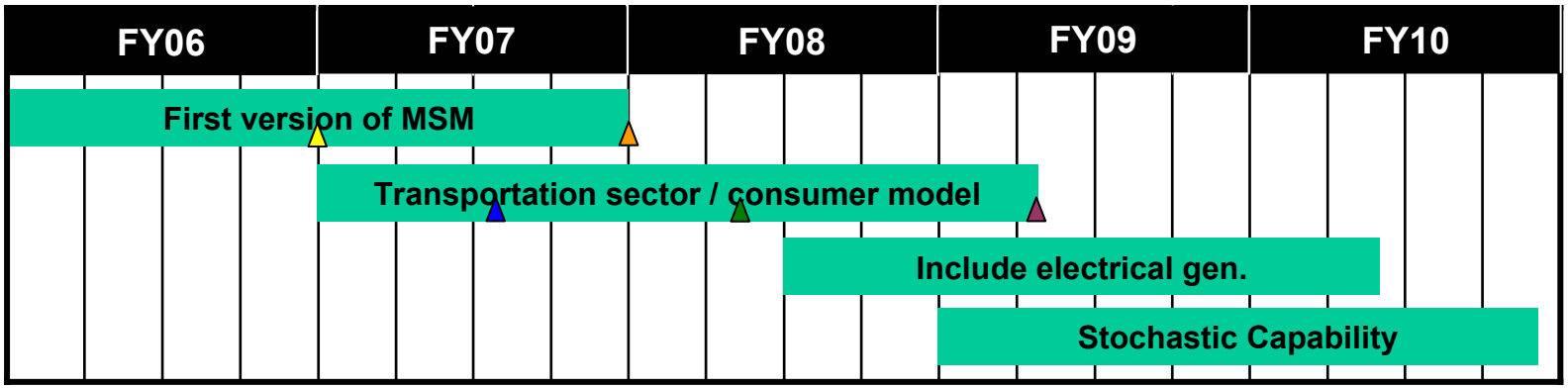
Approach: Validation of the MSM

- **Discussions with model developers**
  - Determine that parameters are being addressed properly
  - Verify that the mapping of links between models is correct
- **Comparison to other analyses**
  - Explain differences between results when they are different
- **Analysis community symposiums**
  - Presentations by analysts
  - Discussions of methodology
  - Develop consensus on proper modeling approach for each analysis issue

Future Work



- First version of the MSM (H2A Production, HDSAM, GREET)
  - Validation of the MSM
  - △ Initial analysis of production/delivery pathways (September 30, 2006)
  - Create a friendly user-interface for the MSM
  - △ Make MSM available on password protected internet site (September 28, 2007)
- Integrate transportation sector / consumer models into MSM
  - Determine next set of issues that need to be addressed
  - Add of temporal and spatial aspects to the MSM
  - ▲ Include either HyDS or HyTrans (April 30, 2007)
  - ▲ Include the model not chosen previously (April 30, 2008)
  - ▲ Review transition strategies using the MSM (January 31, 2009)
- Include stationary electrical generation and infrastructure for a full hydrogen economy (February 28, 2010)
- Include stochastic modeling capability (August 31, 2010)

Summary

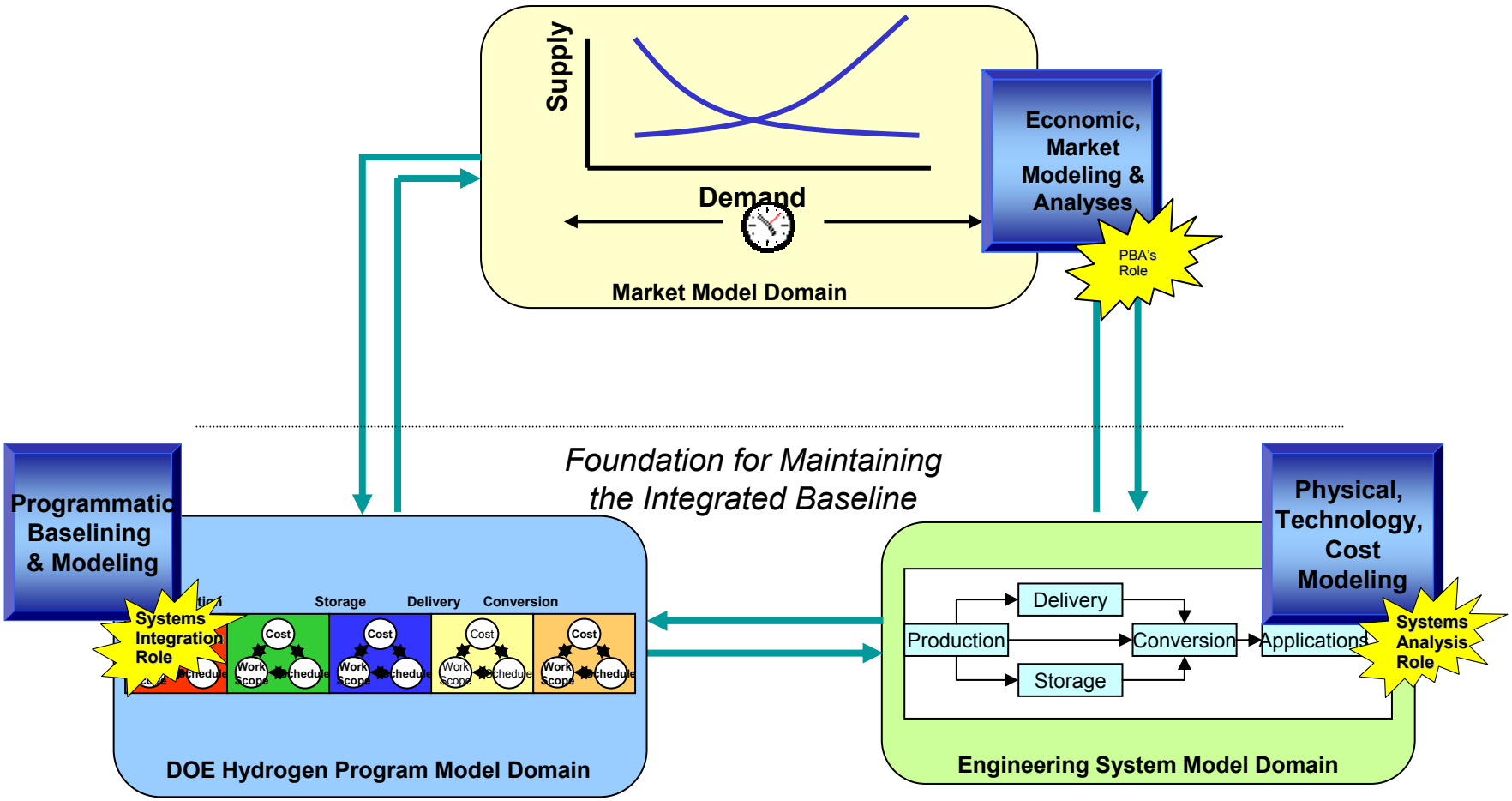
- The MSM is being built to address priority analysis issues
- The Federated Object Model approach is being used to develop the MSM
- H2A Production, HDSAM, and GREET have been linked in the initial version of the MSM
- Preliminary results have been generated
- Validation of the MSM and development of a user interface are underway

Questions

Supplemental Slides

- **Responses to previous year reviewers' comments**
  - **Not reviewed previously**
- **Hydrogen safety**
  - **This is a modeling effort. There are no hydrogen hazards directly associated with it.**
- **Publications and presentations**
  - **There have been no publications on this work.**
  - **There have been no presentations outside the HFCIT program**

Role in EERE Modeling Domain



- **Macro-system model will simulate system performance and enable evaluation of components/interfaces from system level perspective**