

III.11 Macro-System Model

Mark F. Ruth

National Renewable Energy Laboratory

1617 Cole Blvd.

Golden, CO 80401

Phone: (303) 384-6874; Fax: (303) 275-3007; E-mail: mark_ruth@nrel.gov

DOE Technology Development Manager: Fred Joseck

Phone: (202) 586-7932; Fax: (202) 586-9811; E-mail: Fred.Joseck@ee.doe.gov

Subcontractor:

Sandia National Laboratory, Livermore, CA

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Projected End Date: Complete model development by September 2010

Objectives

- Develop a macro-system model (MSM) to support programmatic decisions regarding programmatic investment choices, focus and level of funding, and potential effects of Program changes.
- Use the MSM to support elaboration of viable transition scenarios from a hydrocarbon-based economy to a hydrogen-based economy.
- Support fulfillment of the National Research Council's recommendation that the DOE develop and employ systems analysis and modeling.

Technical Barriers

This project addresses the following technical barriers from the Systems Analysis section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- C. Lack of a Macro-System Model
- F. Lack of Understanding of the Transition of a Hydrocarbon-Based Economy to a Hydrogen-Based Economy

Approach

The MSM will be an engineering model that simulates performance and evolution of the energy infrastructures during transition to a hydrogen economy. Numerous models exist to analyze components and subsystems of an eventual hydrogen economy; however, they are each focused on one or several parts of the hydrogen infrastructure. The MSM will integrate many of those component and subsystem models using a common architecture and address the overarching hydrogen fuel infrastructure as a system.

Development of the MSM will follow the systems engineering approach diagrammed in Figure 1. Initially, requirements for the MSM will be defined. Those requirements include issues the MSM should address, features it needs, and necessary outputs. Alternatives will then be evaluated to determine the best structure for the MSM, which element models should be included, and how they should be integrated. Next, an approach with a timeline and budget will be developed and, finally, model development and integration will begin.

Inputs from analysts and modelers in the hydrogen analysis community are being used to determine issues the MSM needs to address. The following four categories of issues are portrayed in Figure 2 and will be considered:

- **Research and Development:** These issues involve hypothetical fuel cycle costs (i.e., what is the full cost per mile driven and how will it evolve over time?) and the suitability of technical targets and their relationships to each other.
- **Transition:** These issues focus on potential hydrogen infrastructures and how they might compete with the current petroleum infrastructure. Market issues and regional differences, different pathways, and legacy costs of retired infrastructure are included.
- **Financial:** These address corporate and government investment options.
- **Environmental:** Included are issues of resource requirements and emission profiles.

After the specific issues are assembled, model features necessary to address those issues will be fleshed out. Expected features include the following:

- **Distributed Architecture:** A computational technique that links models which analyze individual elements of the system. Distributed architecture will allow the model to stay up-to-date with evolving element models.
- **Competition with the current infrastructure:** Making the transition from the current fuel infrastructure to a hydrogen-based one will be expensive; therefore, competition from other fuel sources must be included to capture how the system might respond.
- **Development of regional infrastructure:** Energy source, delivery, and demand are all regional issues; therefore, the MSM must have a structure that addresses those topics.
- **Capturing the effects of early adopters on transition:** Early adopters (people and organizations who will buy hydrogen-powered vehicles before having economically rational reasons) will drive infrastructure development at a faster rate than otherwise predicted.

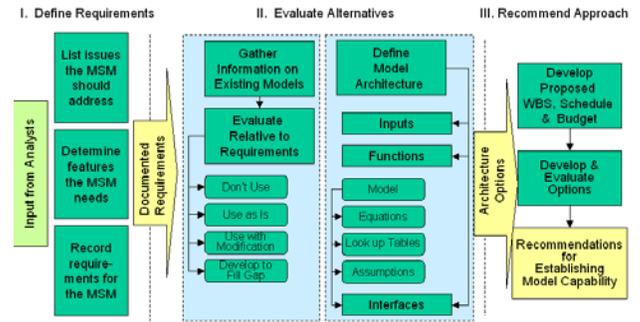


Figure 1. Development Approach for the MSM

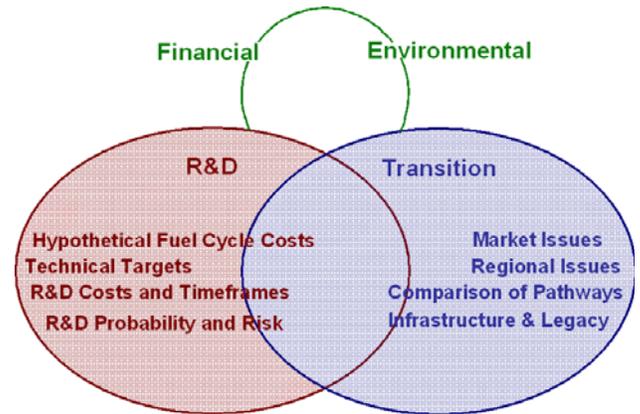


Figure 2. Categories of Issues the MSM Should Address