

VIII.4 HyDRA: Hydrogen Demand and Resource Analysis Tool

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Project End Date: Project continuation and
direction determined annually by DOE

- **Milestone 8:** Complete analysis and studies of resource/feedstock, production/delivery and existing infrastructure for technology readiness (4Q, 2014).

Accomplishments

- Defined 16 functional requirements for the HyDRA tool, 13 of which will be completed in FY 2007 and three which are slated for future releases.
- Identified preliminary data needs for incorporation into HyDRA.
- Incorporated preliminary resource data into the HyDRA model, including data on wind, solar, biomass, coal, natural gas, and water.
- Incorporated hydrogen demand data into the HyDRA model.
- Incorporated limited infrastructure data into the HyDRA model, including roads and existing hydrogen infrastructure.
- Built application functionality, including general mapping capability, layer thresholds, layer hide/emphasize, identification and selection of data, dynamically changing assumptions, security, printing, and downloading.



Objective

Develop a web-based geographic information system (GIS) tool to allow analysts, decision makers, and general users to view, download, and analyze hydrogen demand, resource, and infrastructure data spatially and dynamically.

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:

- (B) Stove-Piped/Siloed Analytical Capability
- (C) Inconsistent Data, Assumptions, and Guidelines
- (D) Suite of Models and Tools

Contribution to Achievement of DOE Systems Analysis Milestones

This project will contribute to achievement of the following DOE Systems Analysis milestones from the Systems Analysis section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- **Milestone 5:** Complete analysis and studies of resource/feedstock, production/delivery and existing infrastructure for various hydrogen scenarios (4Q, 2009).

Introduction

The HyDRA tool was developed to conduct geographic analysis of hydrogen demand, resource and infrastructure spatially in a dynamic web-based environment. This capability is important as resource, demand, and infrastructure will vary regionally for hydrogen production, delivery and dispensing. Existing analyses tend to use national averages. Therefore, a tool is needed to facilitate regional and geographical analyses.

Approach

HyDRA is based on prior work by the National Renewable Energy Laboratory (NREL). Two earlier GIS efforts have been included as data in the model: 1) GIS resource analyses for hydrogen produced from wind, solar, and biomass; and 2) hydrogen demand scenario modeling results. The HyDRA model itself is based on the renewable planning model (RPM) model at NREL, which provides secure, web-based, open-source architecture. This architecture consists of a database, web server, and GIS system and is accessed by web browsers both internal to NREL and external.

The process of building the model began with the development of functional requirements. Next, the team developed a list of the data requirements. Finally, application building and testing was initiated. The model is to be released for beta testing by a few users at the end of June 2007 and will be released for general use in September 2007.

Results

The HyDRA project began with the development of the functional requirements. These requirements explain at a high level what capabilities the model needs. The list of functional requirements follows:

1. Generic viewing maps
2. Resource maps
3. Infrastructure maps
4. Demand maps
5. Layer control
6. Change of underlying assumptions
7. Building the hydrogen system
8. Buffer layers
9. Security
10. Import data
11. Export data
12. Selecting data
13. Print map
14. Emissions
15. Temporal functionality
16. Interaction with other applications

The first 13 of these will be started in FY 2007, while the last three are future requirements.

Once the functional requirements were established, the data requirements for the project were determined. The data needed was categorized as resource, demand, or infrastructure data. The initial resource datasets came from an analysis done by Margaret Mann and Anelia Milbrandt, which determined the potential to produce hydrogen from wind, solar, and biomass. The initial demand datasets came from an analysis done by Margo Melendez and Anelia Milbrandt. The demand dataset is considered complete, but additional work needs to be done to acquire resource and infrastructure data. Figure 1 outlines the datasets needed for resource, while Figure 2 outlines the datasets needed for infrastructure.

After the functional and data requirements were developed, the application design and building were begun. In addition to basic mapping functionality, such as the ability to zoom, pan, print, view a scale, and view a legend, the application has the ability to view different data layers, threshold the displayed layers, hide or emphasize different data, layer maps, view underlying

Resource Data

Renewable

Wind

Solar

Biomass

Offshore wind

Hydro

Geothermal

Coal

Natural gas

Uranium

Water

Geologic features

Sequestration

Hydrogen storage

Oil/gasoline



Energy production potential
Hydrogen production potential
Usage of feedstock by utilities
Competition



FIGURE 1. Resource Data Required for HyDRA (Green bold items have been incorporated into the application, green italics items have been started, and black items are future items.)

Infrastructure Data

Electricity

Natural gas

Water

Capacity

Location

Availability

Consumption

Rates



Hydrogen infrastructure

Power plants

Renewable installations

Gas stations

FIGURE 2. Infrastructure Data Required for HyDRA (The integration of green bold items into the application has been started, and black items are future items.)

data, dynamically change assumptions, and provide for security. Figure 3 shows the results of a nationwide case study using HyDRA to find a site with good biomass resource, high demand, no nearby hydrogen refueling infrastructure, and a nearby hydrogen production plant. The green areas show good biomass potential, the yellow and orange areas show high demand, and the squares

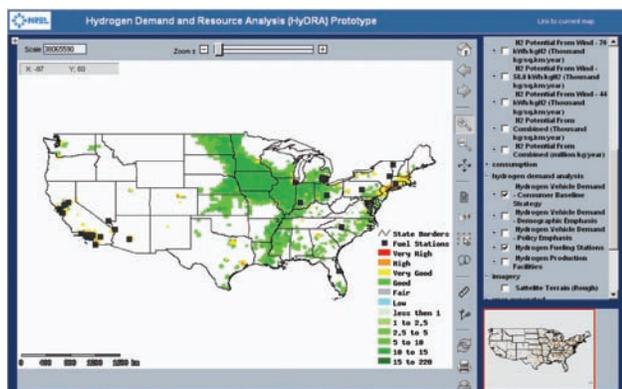


FIGURE 3. Nationwide Case Study Using HyDRA to Find a Site with Good Biomass Resource, High Demand, No Nearby Hydrogen Refueling Infrastructure, and a Nearby Hydrogen Production Plant

show existing hydrogen refueling locations. Figure 4 shows how HyDRA can be used to zoom in on a single location to better see how the nationwide case study could be focused to the Minneapolis-St. Paul area of Minnesota. The colors and symbols are the same as in the nationwide map, but triangles are added to show hydrogen production locations.

Conclusions and Future Directions

Conclusions

- HyDRA concept is a Web-based, dynamic, highly interactive demand and resource tool for:
 - viewing, downloading, and reporting on resource, demand, and infrastructure data;
 - spatially representing analysis results; and
 - regional analysis.
- Current DOE resource and demand analysis is static.
- Existing DOE models need or could use consistent demand and resource data and regional capabilities such as Hydrogen Development System (HyDS), HyTrans, Macro System Model (MSM), and others.
- Hydra is built on existing work at NREL, including:
 - GIS resource analysis;
 - hydrogen demand scenario analysis; and
 - renewable planning model.

Future Directions

- June 2007: beta release.
- June – August 2007: develop Release 2 with
 - additional resource layers;
 - infrastructure layers; and

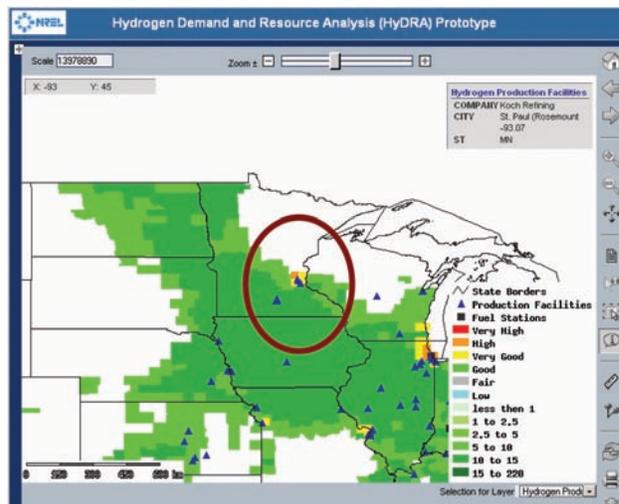


FIGURE 4. Zoom of Minnesota for Case Study Using HyDRA to Find a Site with Good Biomass Resource, High Demand, No Nearby Hydrogen Refueling Infrastructure, and a Nearby Hydrogen Production Plant

- enhanced application functionality such as for uploading and downloading data.

- September 2007: test and release.
- FY 2008 and beyond: temporal functionality, interfaces with other applications (MSM, HyDS, HyTrans), additional resource and infrastructure layers, emissions.

FY 2007 Publications/Presentations

1. Presented at Fuel Pathway and Integration Tech Team meeting (March 2007).
2. Presented at the National Hydrogen Association meeting for fuels and automotive directors in San Antonio (March 2007).
3. Presented at the DOE Hydrogen Program 2007 Annual Merit Review (May 2007).

References

1. Melendez, M.; Milbrandt, A., “Geographically Based Hydrogen Consumer Demand and Infrastructure Analysis: Final Report,” NREL Report No. TP-560-40373, (2006).
2. Milbrandt, A. and Mann, M., “Potential for Producing Hydrogen from Key Renewable Resources in the United States,” NREL Report No. TP-640-41134, (2006).