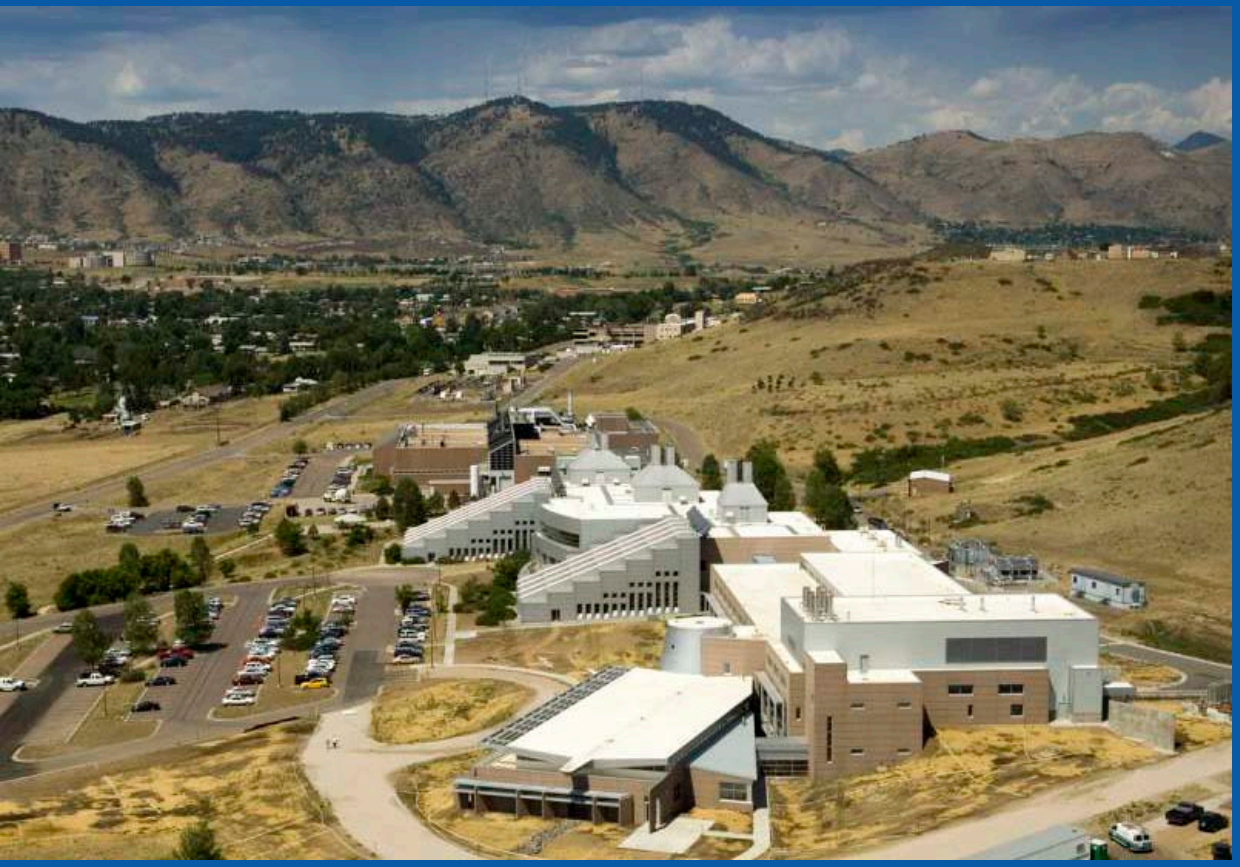
National Renewable Energy Laboratory
Innovation for Our Energy Future

Recent Developments in the Hydrogen Demand and Resource Assessment (HyDRA) Model



Johanna Levene
Dan Getman

National Renewable Energy Laboratory

June 8, 2010

2010 Annual Merit Review and Peer Evaluation Meeting

Project ID # AN017

This presentation does not contain any proprietary, confidential, or otherwise restricted info

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy operated by the Alliance for Sustainable Energy, LLC

Overview

Timeline

- Project start date – September 2006
- Project end date – Ongoing
- Percent complete – Ongoing

Barriers

- Stove-piped/Siloed Analytical Capability [4.5.B]
- Inconsistent data, assumptions, and guidelines [4.5.C]
- Suite of models and tools [4.5.D]

Budget

- Total Project Funding: $1,120k
  - 100% DOE-funded
- Funding for FY 2009 – $266K
- Funding for FY 2010 – $300K

Partners

- NREL project with support from A Mountain Top, LLC, for programming expertise

Relevance: Why Spatial Analyses and Datasets?

- Estimating hydrogen demand, finding and organizing resources, and designing, building, and managing the hydrogen production and distribution infrastructure all require spatial and temporal modeling and analysis which require and produce spatial and temporal datasets.

- The input and output from these analysis require the development of a common visualization platform so information can be used to communicate to analysts, decision makers and policy makers.

The transition to hydrogen requires an understanding of the spatial relationships and interdependencies of a wide range of changing datasets.

Relevance: The History of HyDRA

HyDRA has evolved from a basic display of spatial data to a repository of over 90 datasets with dynamic integration to other models and repositories.

FY07 – Dynamic Maps

- Display spatial layers
- Provide basic Geographic Information System (GIS) capabilities
- View existing spatial analyses in a dynamic environment

FY08 – FY09 – Static Repository

- Collect and display over 80 different datasets related to demand, resource, and infrastructure (maintain manually)
- Manual Macro System Model (MSM) integration

FY10 – Dynamic Repository

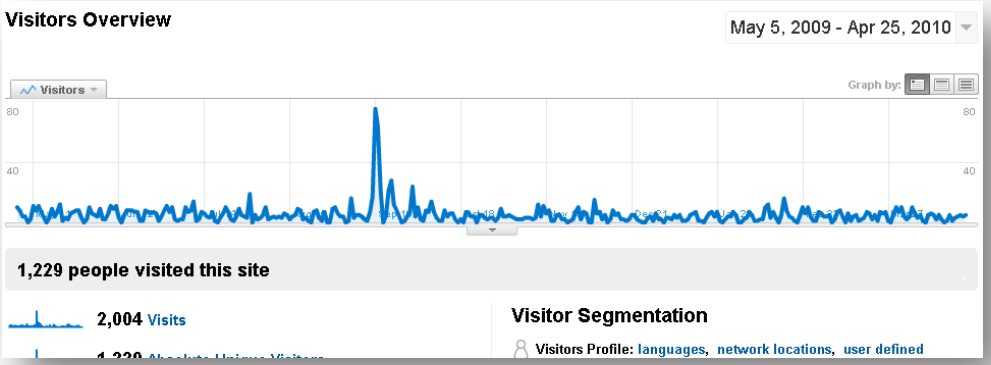
- Dynamic integration with MSM, SERA (Scenario Evaluation, Regionalization & Analysis) and other models
- Automatically update core datasets (in process)
- Add temporal capabilities (in process)

Relevance: Impact on Barriers

Barrier	***Impact***
Stove-piped/Siloed Analytical Capability [4.5.B]	• HyDRA integrates with SERA and MSM providing input data and displaying results. • HyDRA's Web Feature Service (WFS) and Web Map Service (WMS) standards lead to easy integration with other GIS models.
Inconsistent data, assumptions, and guidelines [4.5.C]	• HyDRA provides a common repository for spatial data inputs and results related to hydrogen. • HyDRA is being built in FY10 to automatically update datasets.
Suite of Models and Tools [4.5.D]	• HyDRA is interoperable with SERA and MSM and provides spatial data to both models for analyses. • Through MSM integration, spatial data can be used to make GREET and H2A results regionally accurate.

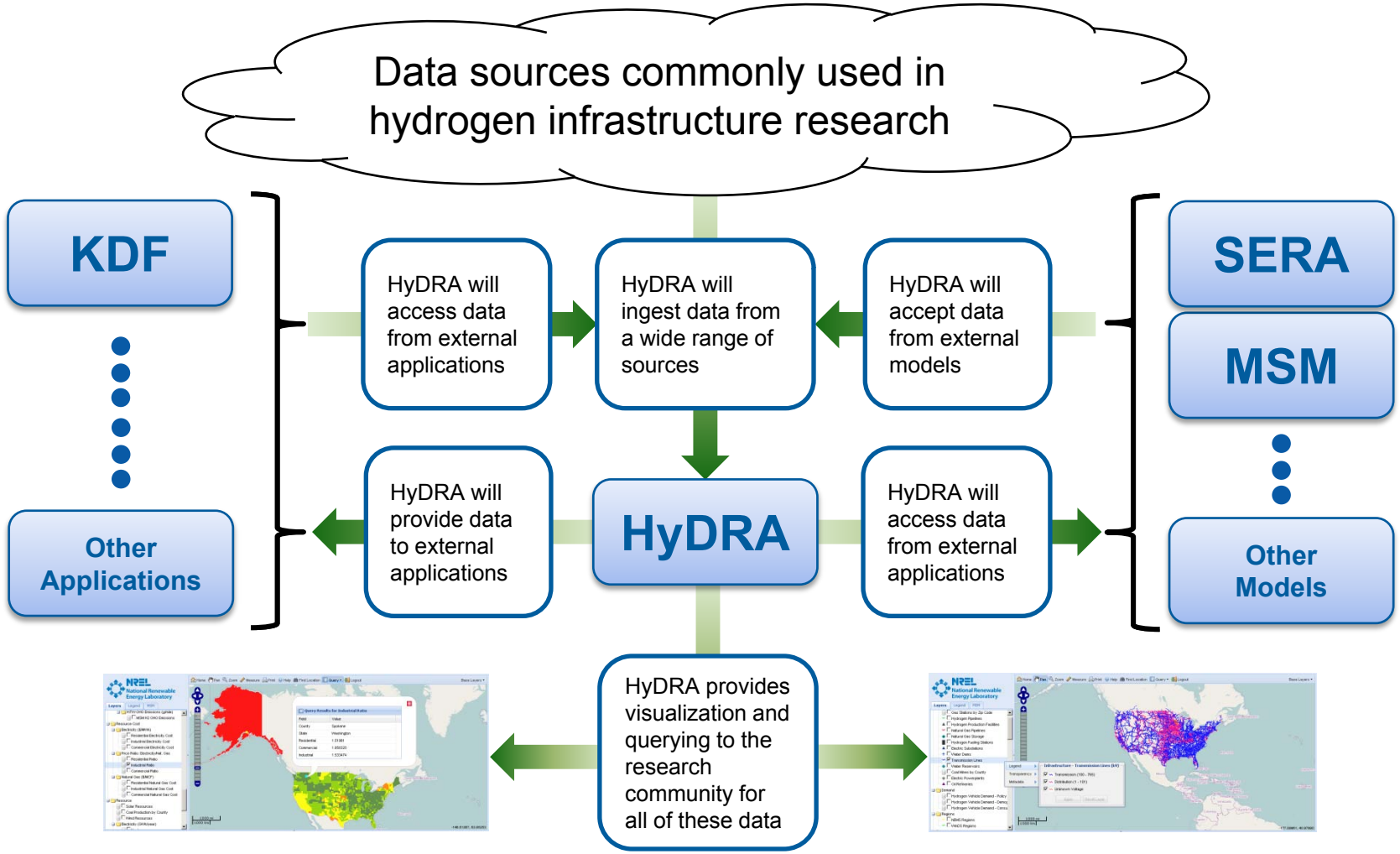
Approach: Reaching a Diverse User Population on the Web

- 257 users from a diverse population including
  - Universities (University of Chicago, Sonoma State University, University of Calfornia, Davis)
  - Industry (Air Products and Chemicals, Inc., Apple, Matheson Tri-gas)
  - Government Agencies (Office of the Secretary of Defense, DOE)
- Statistics from May 5, 2009 – April 25, 2010
  - From Google Analytics
  - 2004 visits
  - Average 5.63 visits/day
  - 62 countries
  - 83% from USA



Approach: Integration with other models

HyDRA is a repository for spatial demand, resource and infrastructure data related to hydrogen. Data is provided in maps and via model integration.

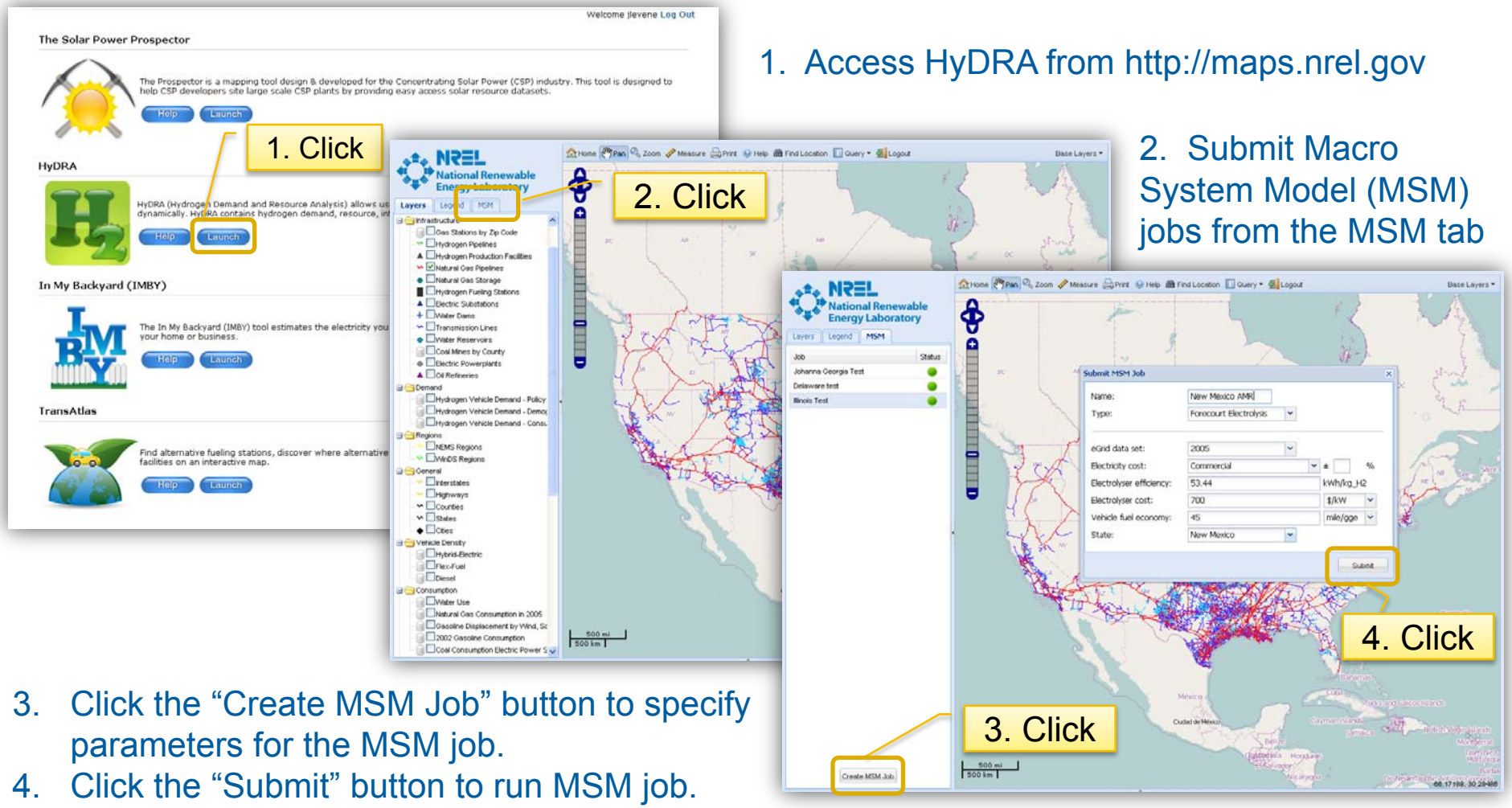


Approach: Milestones

FY	Milestone	Description	Date	Status
2009	2.4.2	Release beta version 1.4	May 2009	Complete
	2.4.3	Release production version 1.3	May 2009	Complete
	2.4.4	Release beta version 1.5	Sep 2009	Complete
	2.4.5	Release production version 1.4	Sep 2009	Complete
2010	2.4.1	Releases of new HyDRA functionality	April 2010	Complete
	2.4.2	New layers and metadata to support layers	Aug 2010	In Process
	2.4.3	Complete beta version of enhanced analytic capabilities	Sep 2010	In Process

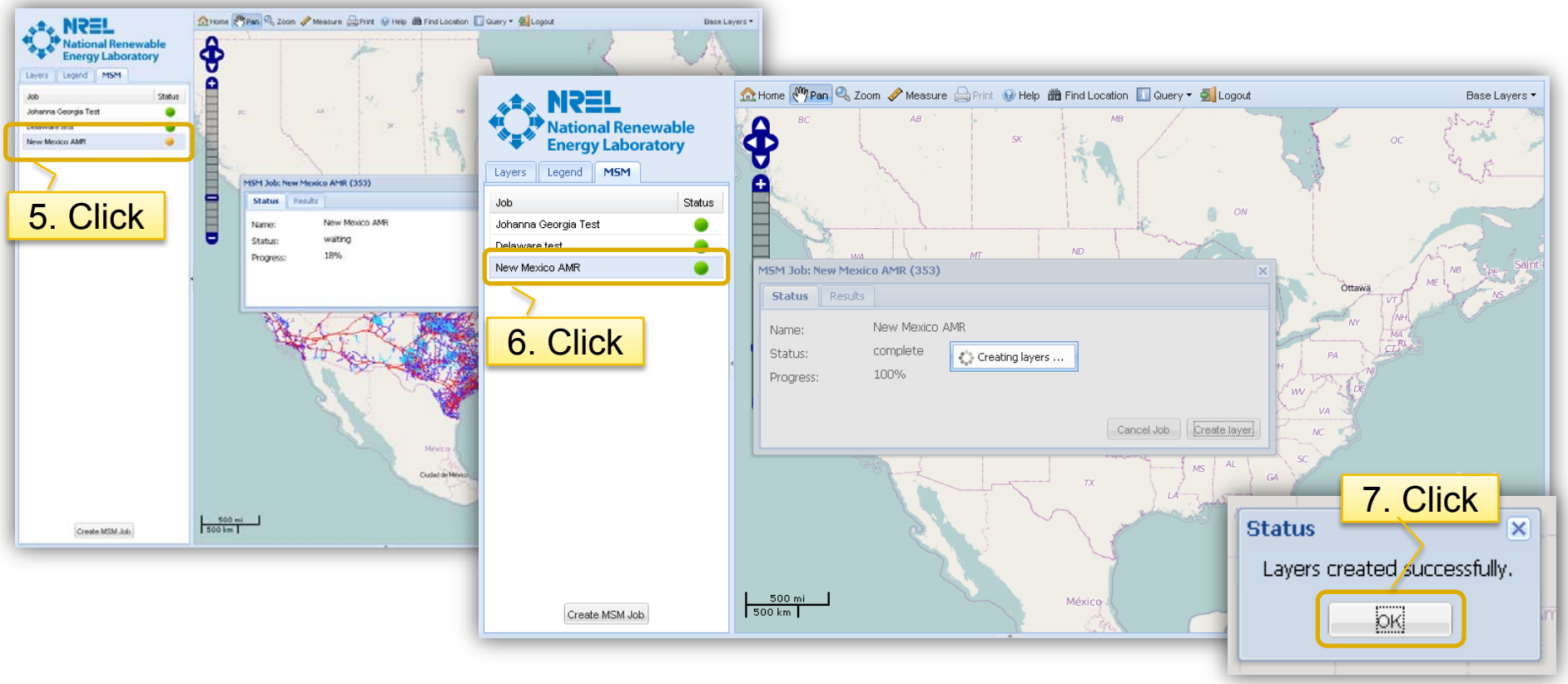
Accomplishment: MSM dynamic integration

HyDRA can now call MSM scenarios for any state to determine hydrogen price, WTW energy use and GHG emissions in each county.



1. Access HyDRA from http://maps.nrel.gov
2. Submit Macro System Model (MSM) jobs from the MSM tab
3. Click the “Create MSM Job” button to specify parameters for the MSM job.
4. Click the “Submit” button to run MSM job.

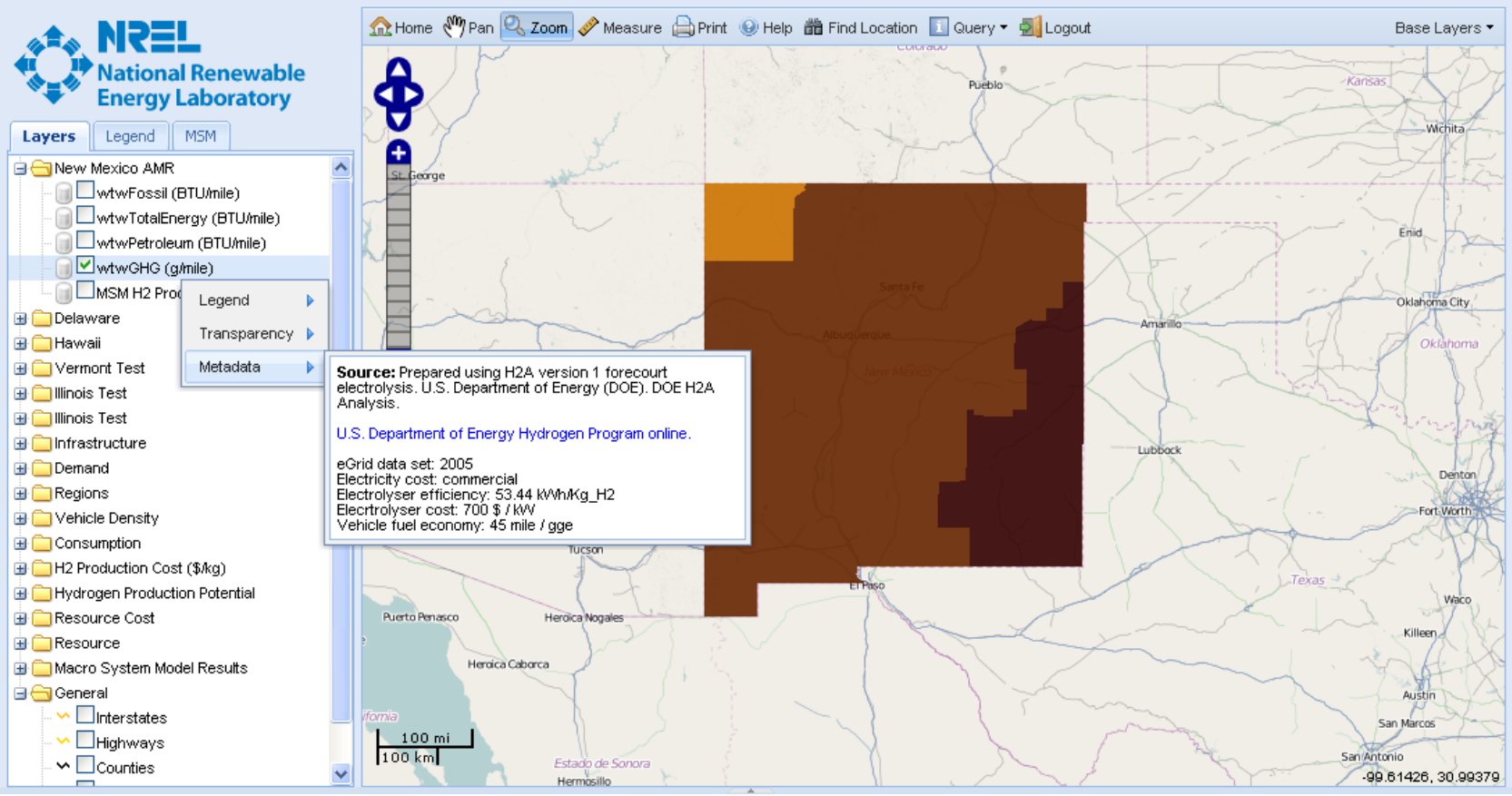
Accomplishment: MSM dynamic integration



5. Click the job during runtime to see status or cancel job. (MSM jobs take ~5 minutes per county to run).
6. When the job status turns green, click on the job name then “Create Layers” to load new layers.
7. When layers are created click the okay button and return to the layer tree to visualize new layers.

Accomplishment: MSM dynamic integration

HyDRA MSM interface will provide state level maps of WTW fossil energy, total energy, petroleum energy, GHG emissions, H2 cost, and H2 high and low cost sensitivities (based on feedstock cost variance).



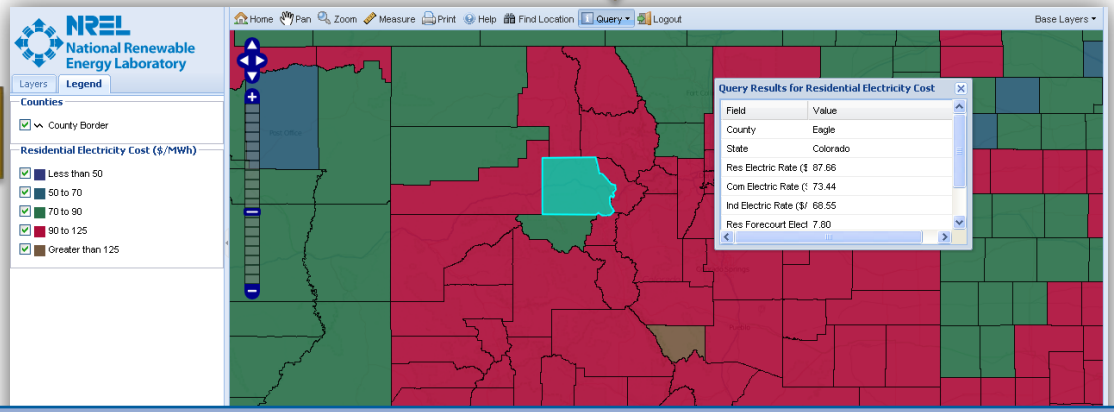
8. Data is stored in folder with the same name as the job name.
9. Assumptions for the run are available in the metadata for the layers(right click on layer).

Accomplishment: MSM dynamic integration

HyDRA now provides county level data to MSM to calculate specific hydrogen price, WTW energy use and GHG emissions for any county.

1. MSM calls a HyDRA web service to query for a county's data.
   - Represented by the FIPS
   - 08037 = Eagle County CO

2. HyDRA returns county data to MSM
   - Electricity rates
   - Natural gas rates
   - Grid mix

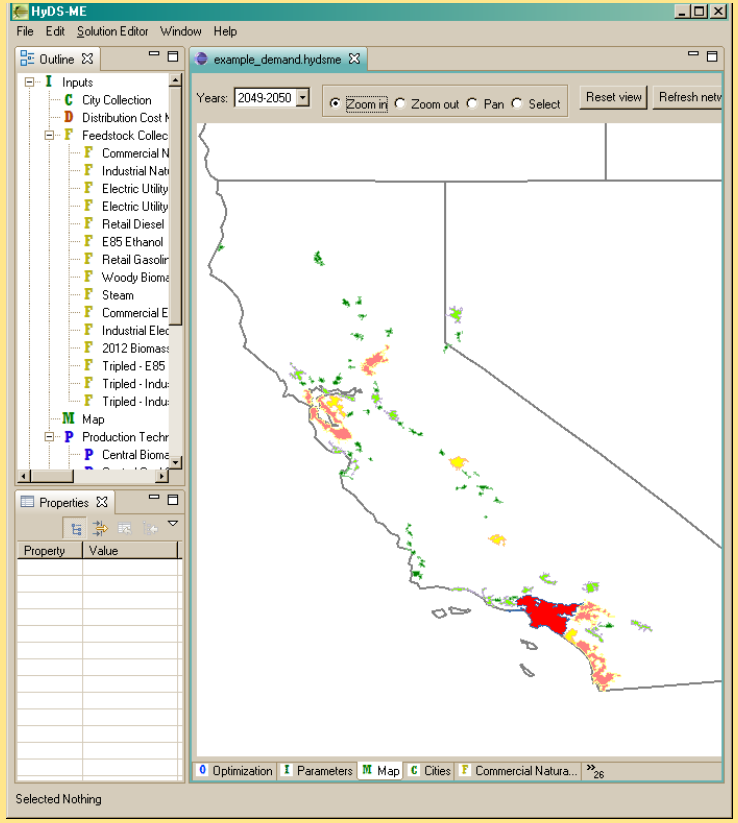


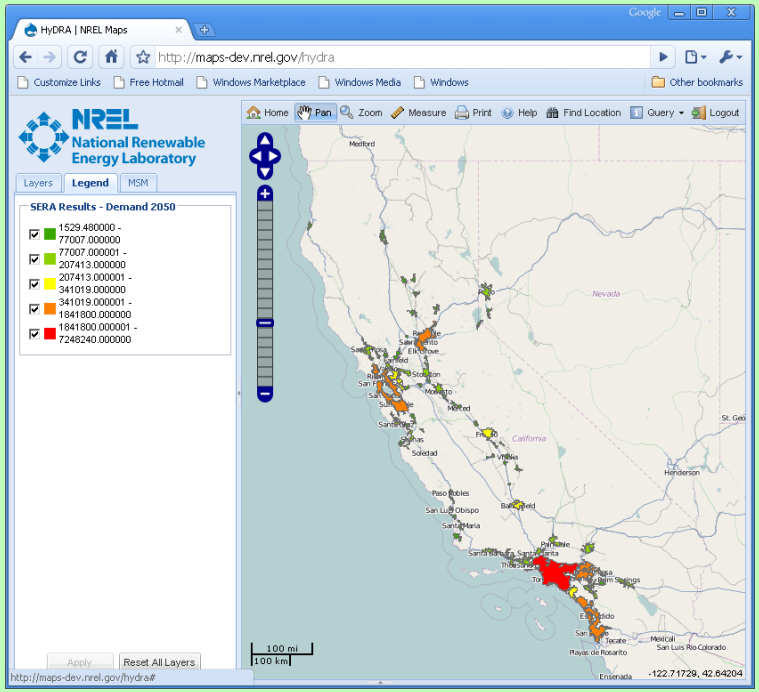
http://maps.nrel.gov/hydra/services/msm/query/county/08037

Accomplishment: SERA integration

SERA provides . . .

- Hydrogen infrastructure, by year
- Hydrogen delivered cost, by year





HyDRA provides . . .

- Hydrogen demand scenarios
- Energy/feedstock price forecasts
- Existing infrastructure
- Background information

HyDRA is the spatial data repository for SERA input and results data

Accomplishment: SERA datasets

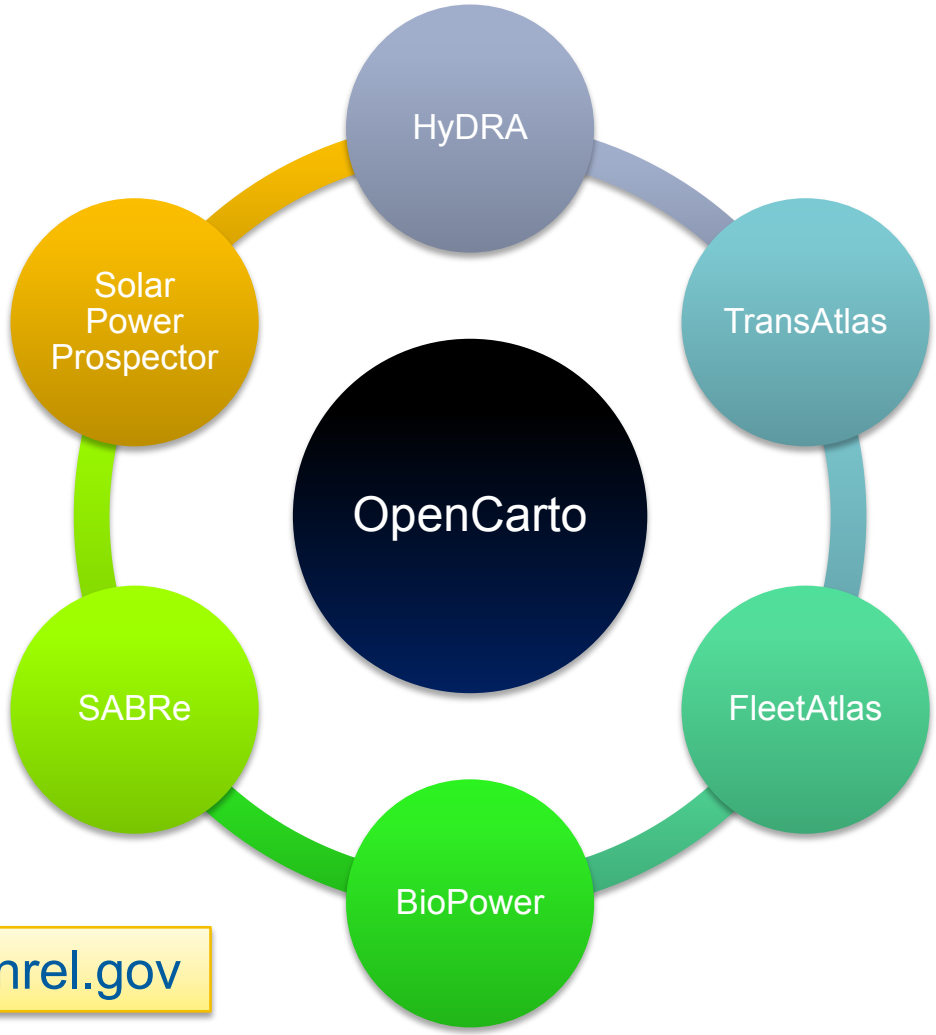
Datasets were added to HyDRA for SERA integration. Both input and results datasets expand the capabilities of HyDRA.

Layers	Source	SERA Input	SERA Result
Hydrogen demand scenarios	NAS	X	
Energy and feedstock cost forecasts	EIA	X	
Urban Areas	Census	X	
Hydrogen Production Sites	HSIP	X	
Sequestration Sites	NATCARB	X	
Hydrogen Infrastructure Buildout	SERA		X
Delivered Cost of Hydrogen to Urban Areas	SERA		X

Collaborations – OpenCarto Platform

HyDRA is built on OpenCarto, a web-based GIS platform that hosts six web mapping tools funded by seven different clients

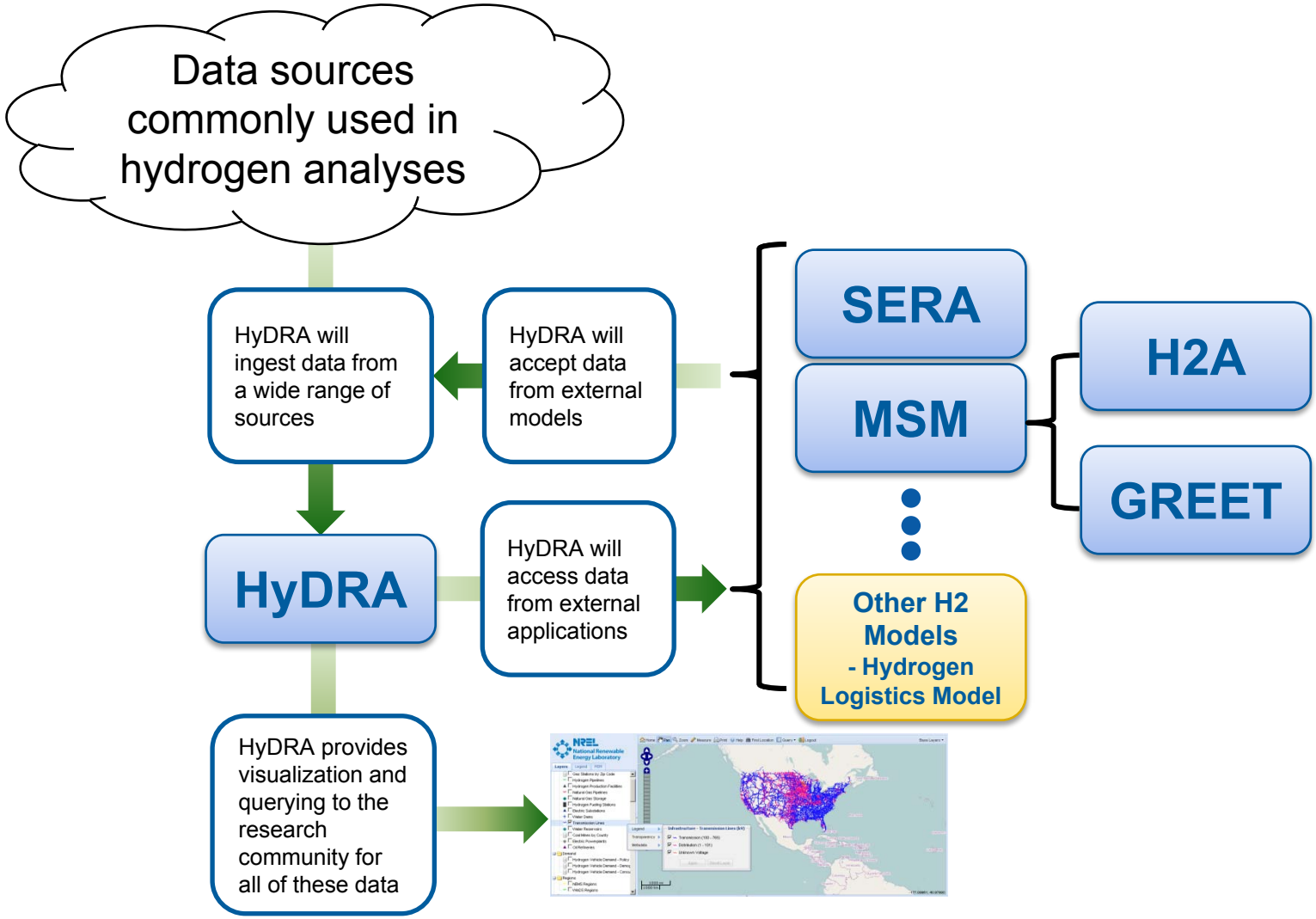
Client	Tool
DOE Hydrogen	HyDRA
DOE Biomass	BioPower and SABRe
DOE Clean Cities	TransAtlas
DOE FEMP	FleetAtlas
DOE Vehicle Technologies	FleetAtlas
DOE Solar	Solar Power Prospector
EPA	Biopower



Tools are available at http://maps.nrel.gov

Collaborations – HyDRA and Other Hydrogen Models

HyDRA integrates and collaborates with a suite of hydrogen models.



Collaborations – HyDRA and External Data and Models

The development of the hydrogen infrastructure requires collaboration between researchers and analysts in various scientific domains. The interdependencies between domains results in a need for data sharing.

- Supporting interoperability between researchers and analysts focusing on the hydrogen infrastructure is a prominent goal of the work being done on the HyDRA project in FY2010.
- System design changes are currently being implemented that will allow HyDRA to both accept data from and make data available to external models and applications. This development is focused on the SERA model and allowing HyDRA to provide access to data for use as input for SERA and also to act as a venue for SERA results.
- These enhancements will also support interoperability between HyDRA and other models, such as the Bioenergy KDF, which is a source for data and research results in Bioenergy, and will allow biomass data needed by the SERA model to be automatically ingested into HyDRA.

Proposed Future Work – FY10

Functionality that is intended to be completed in FY 2010

- Implement functionality to support further interoperability between HyDRA and the SERA model
- Develop a process for automatically updating SERA input data in the HyDRA application on a regular basis

Functionality that will begin in FY 2010 and be finalized in FY 2011

- Develop a prototype to explore, visualize and display temporal and multivariate datasets
- Develop complex querying capability to analyze temporal and multivariate datasets
  - Develop a prototype interface to perform complex queries. These queries can be comprised of any combination of attributes and can also include spatial query parameters.

Automatic updates of data and prototyping the exploration of temporal and multivariate datasets are the core of remaining FY10 work.

Proposed Future Work – FY11

- Finalize temporal and multivariate dataset visualization
  - Provide an interface to display and print maps and charts for datasets
  - Change map classification and charting variables
  - Export datasets
- Finalize complex querying capability for temporal and multivariate datasets in HyDRA
- Extend automated data acquisition and ingestion capabilities
  - Increase the number of datasets included in HyDRA
  - Provide data in a variety of formats for easy of interoperability and data maintenance
  - Decrease redundancy associated with downloading and reformatting data across DOE analysis and modeling projects when the same data is needed as input within multiple modeling and analysis applications
  - Coordinate with researchers, data providers, and data repositories to select appropriate datasets and reduce redundancy

Summary

Relevance

- Dynamic repository for spatial data inputs and spatial data results

Approach

- Web-based interactive GIS analysis reaching universities government agencies, and industry
- Repository for 80+ datasets for analysis and integration

Accomplishments

- Dynamic integration with MSM
- Integration with SERA model
- Addition of new datasets

Collaboration

- 6 DOE programs and EPA collaborate to build the OpenCarto platform, on which HyDRA is built
- Integration with MSM and SERA models

Future Work

- Build temporal and multivariate dataset visualization and querying
- Automate data acquisition, updating and processing.