

HyDRA:

Hydrogen Demand and Resource Analysis Tool

Witt Sparks

National Renewable Energy Laboratory

June 12, 2008

Project ID #AN8



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

Overview

Timeline

Project start date – September 2006

Project end date – On Going

Percent complete – 50% complete

Budget

Total project funding – 100% DOE share

Funding received in FY 2007 – \$305k

Funding for FY 2008 – \$249k

Barriers

Systems Analysis Barriers

Stove-piped/siloed analytical capability

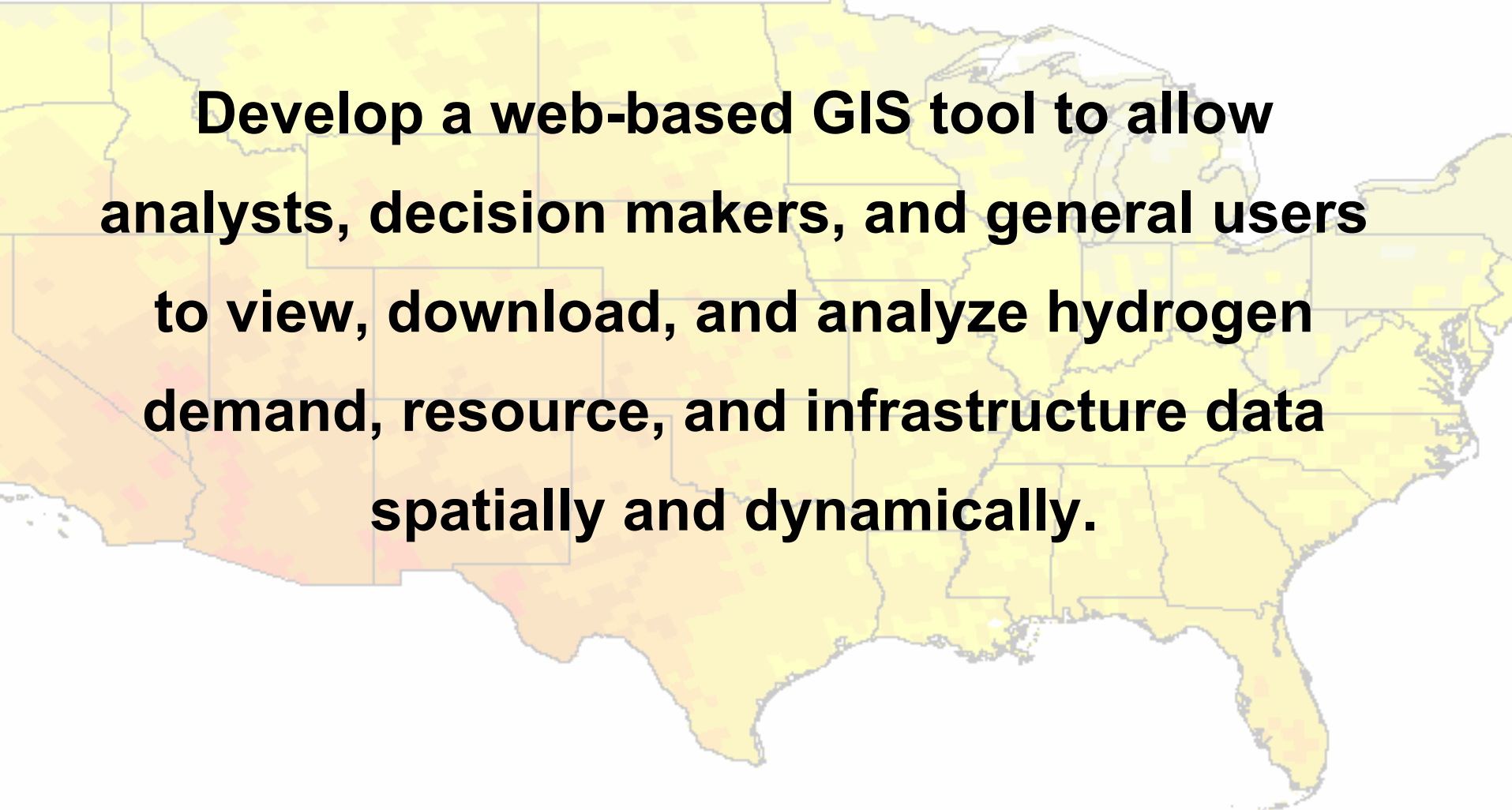
Inconsistent data, assumptions, and guidelines

Suite of models and tools

Partners

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

Objective



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

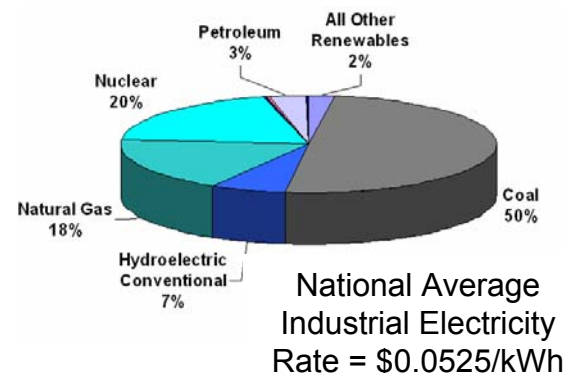
Milestones

June 2007	November 2007	May 2008	September 2008
Application Milestones			
<ul style="list-style-type: none"> • HyDRA beta released to users • General mapping functionality • Dynamically change assumptions • Security 	<ul style="list-style-type: none"> • Legend and Layer control • User action queuing • Data import and export 	<ul style="list-style-type: none"> • Restrict access to sensitive data • Graph data from selected layers 	<ul style="list-style-type: none"> • Improve performance and look and feel • Macro System Model Interface
Data Milestones			
<ul style="list-style-type: none"> • 17 datasets 		<ul style="list-style-type: none"> • 31 datasets 	<ul style="list-style-type: none"> • 10-plus new datasets

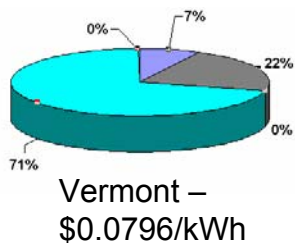
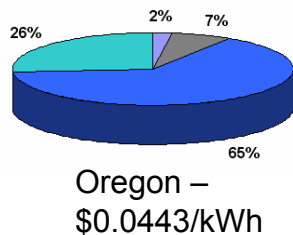
Approach

Spatial Analysis for Hydrogen

- Energy Carrier
- Produced from Various Feedstocks

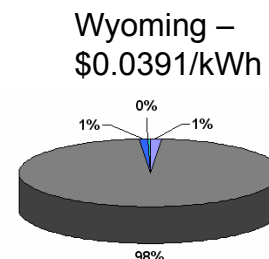


Resource, Demand, and Infrastructure Vary Regionally



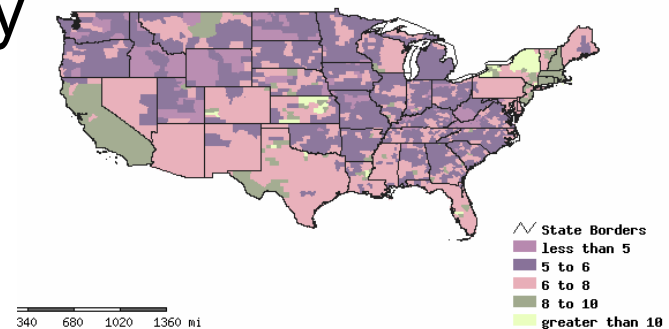
- Move Beyond National Averages
- Facilitate Regional and Local Analyses

Builds on Existing Tools and Models

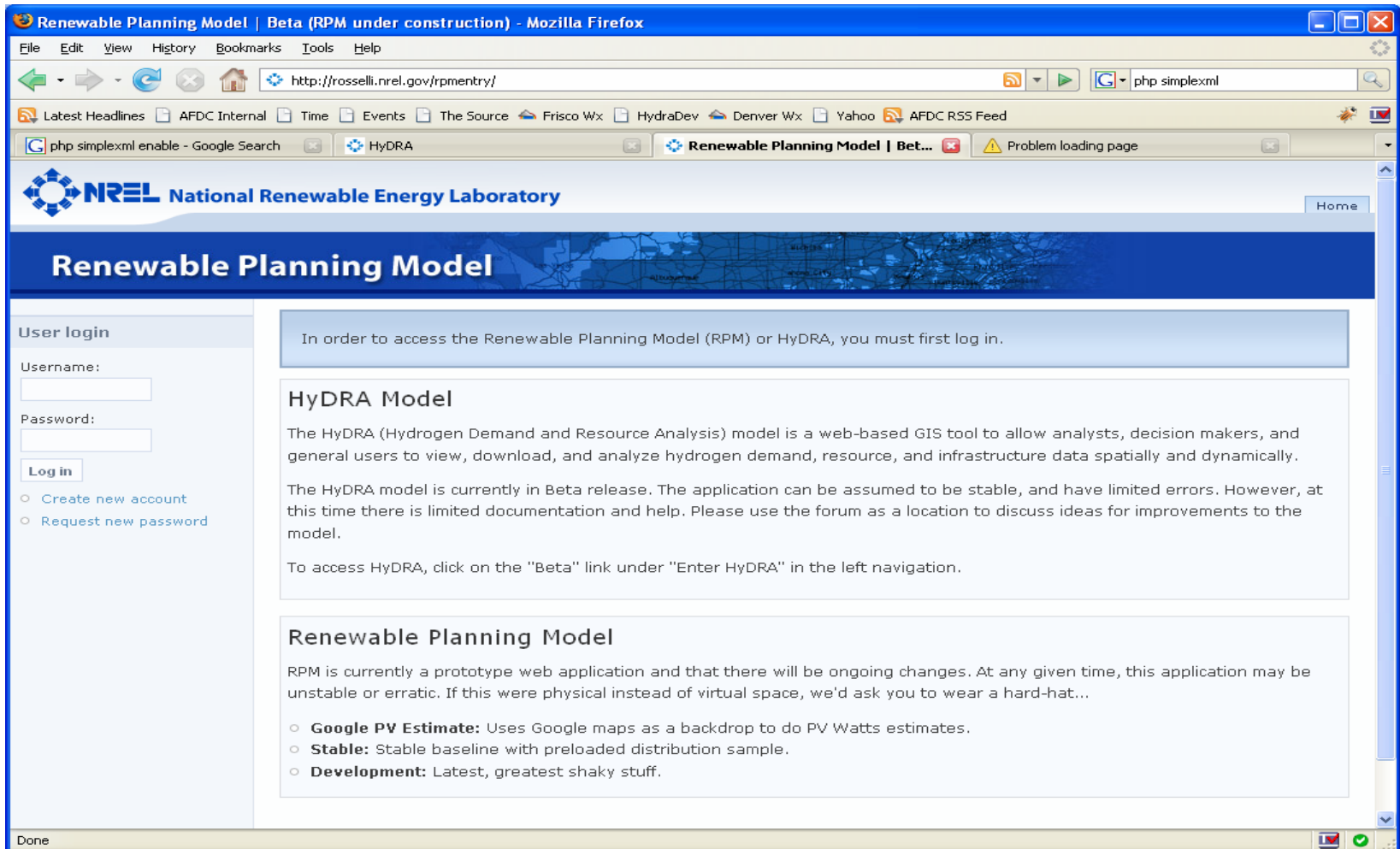


Accomplishments

- Created and integrated 48 datasets viewable as graphical maps.
 - Resource Cost and Availability
 - Hydrogen Production Cost
 - Resource Consumption
 - Hydrogen Demand
 - Infrastructure
- Implemented data manipulation and analysis tools.
- Implemented application security



Accomplishments – Data Security



The screenshot shows a Mozilla Firefox browser window displaying the Renewable Planning Model website. The browser's address bar shows the URL `http://rosselli.nrel.gov/rpmentry/`. The website header includes the NREL logo and the text "National Renewable Energy Laboratory". The main heading is "Renewable Planning Model".

User login

Username:

Password:

- [Create new account](#)
- [Request new password](#)

In order to access the Renewable Planning Model (RPM) or HyDRA, you must first log in.

HyDRA Model

The HyDRA (Hydrogen Demand and Resource Analysis) model is a web-based GIS tool to allow analysts, decision makers, and general users to view, download, and analyze hydrogen demand, resource, and infrastructure data spatially and dynamically.

The HyDRA model is currently in Beta release. The application can be assumed to be stable, and have limited errors. However, at this time there is limited documentation and help. Please use the forum as a location to discuss ideas for improvements to the model.

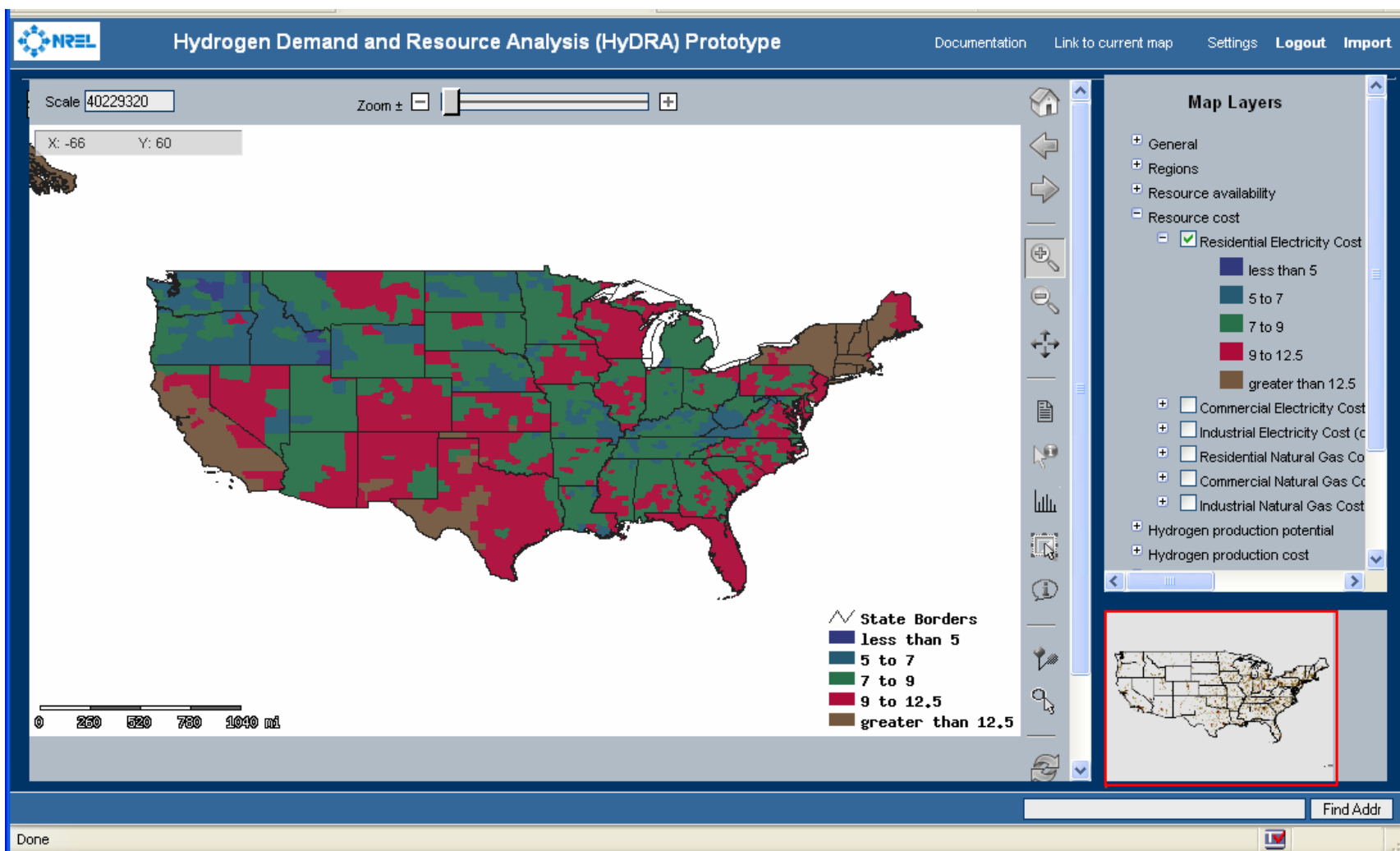
To access HyDRA, click on the "Beta" link under "Enter HyDRA" in the left navigation.

Renewable Planning Model

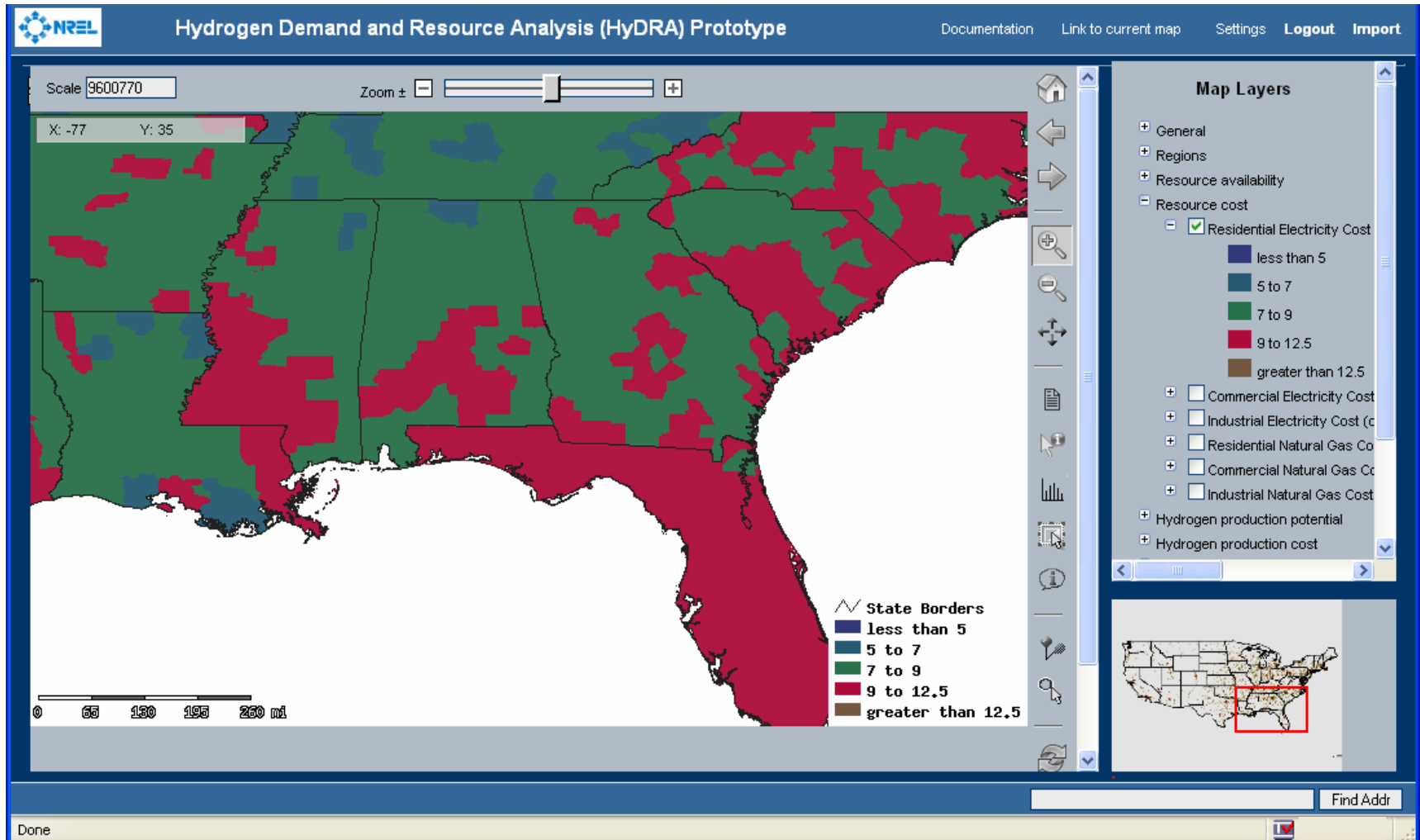
RPM is currently a prototype web application and that there will be ongoing changes. At any given time, this application may be unstable or erratic. If this were physical instead of virtual space, we'd ask you to wear a hard-hat...

- Google PV Estimate:** Uses Google maps as a backdrop to do PV Watts estimates.
- Stable:** Stable baseline with preloaded distribution sample.
- Development:** Latest, greatest shaky stuff.

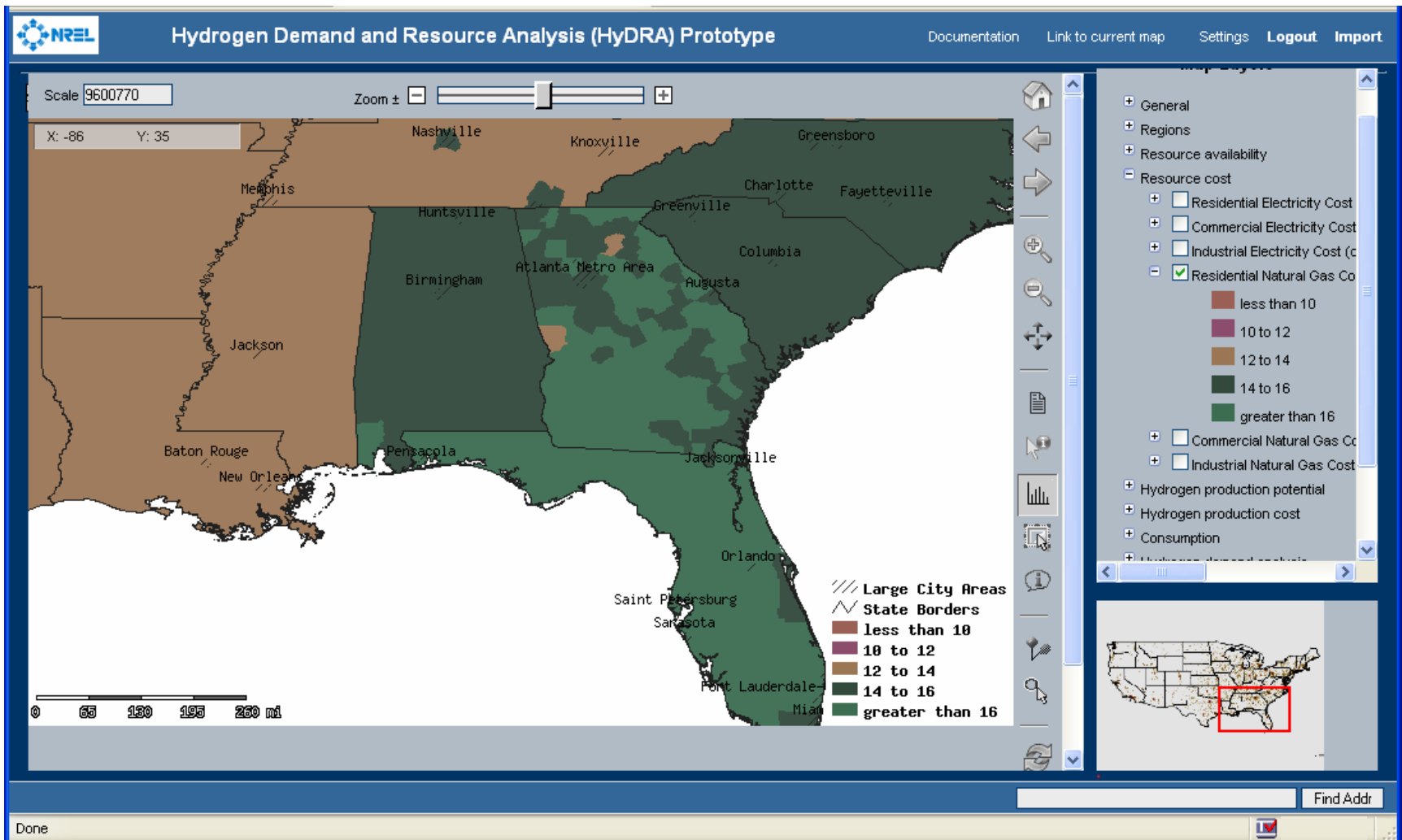
Accomplishments – Electricity Cost



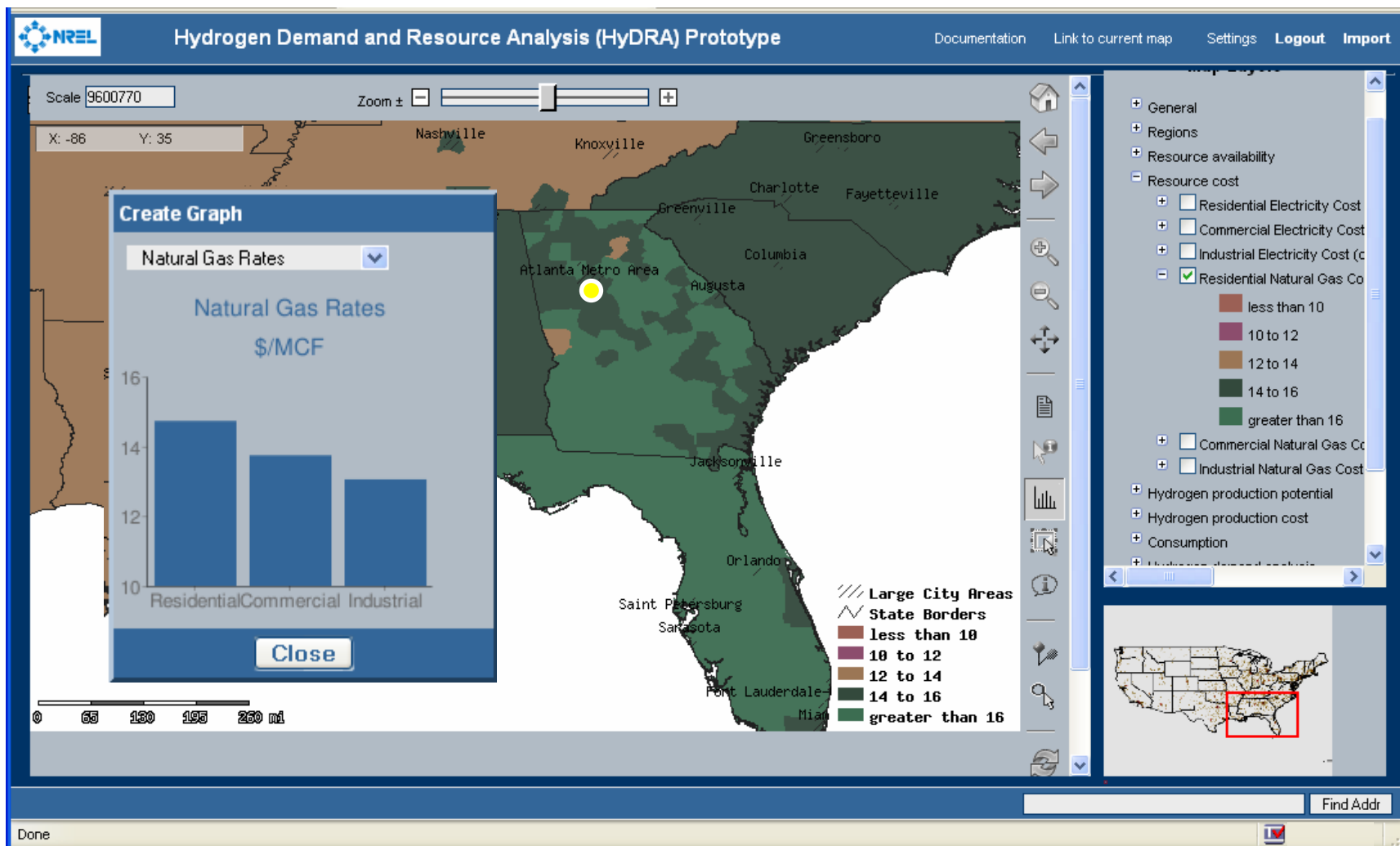
Accomplishments – Electricity Cost



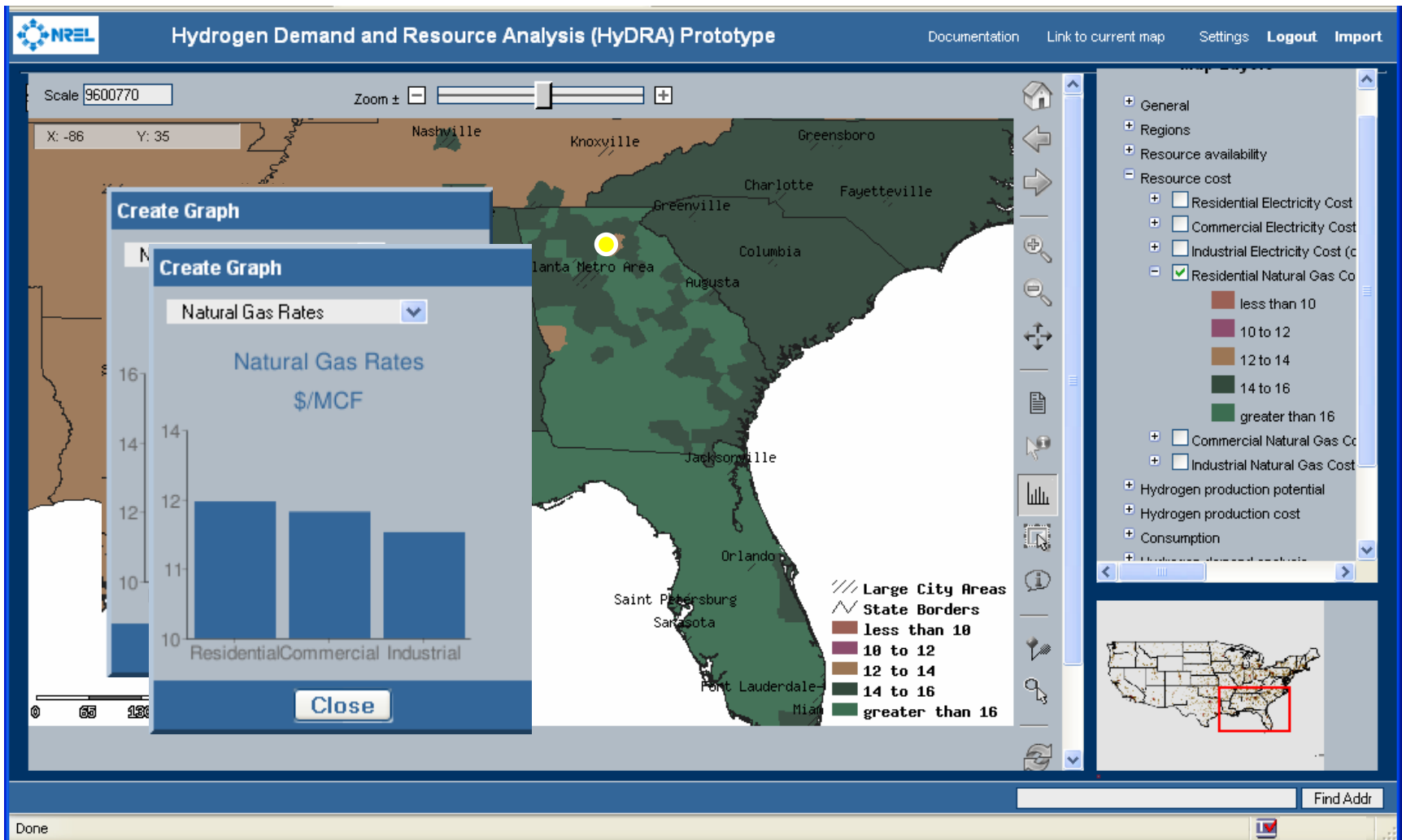
Accomplishments – Natural Gas Cost



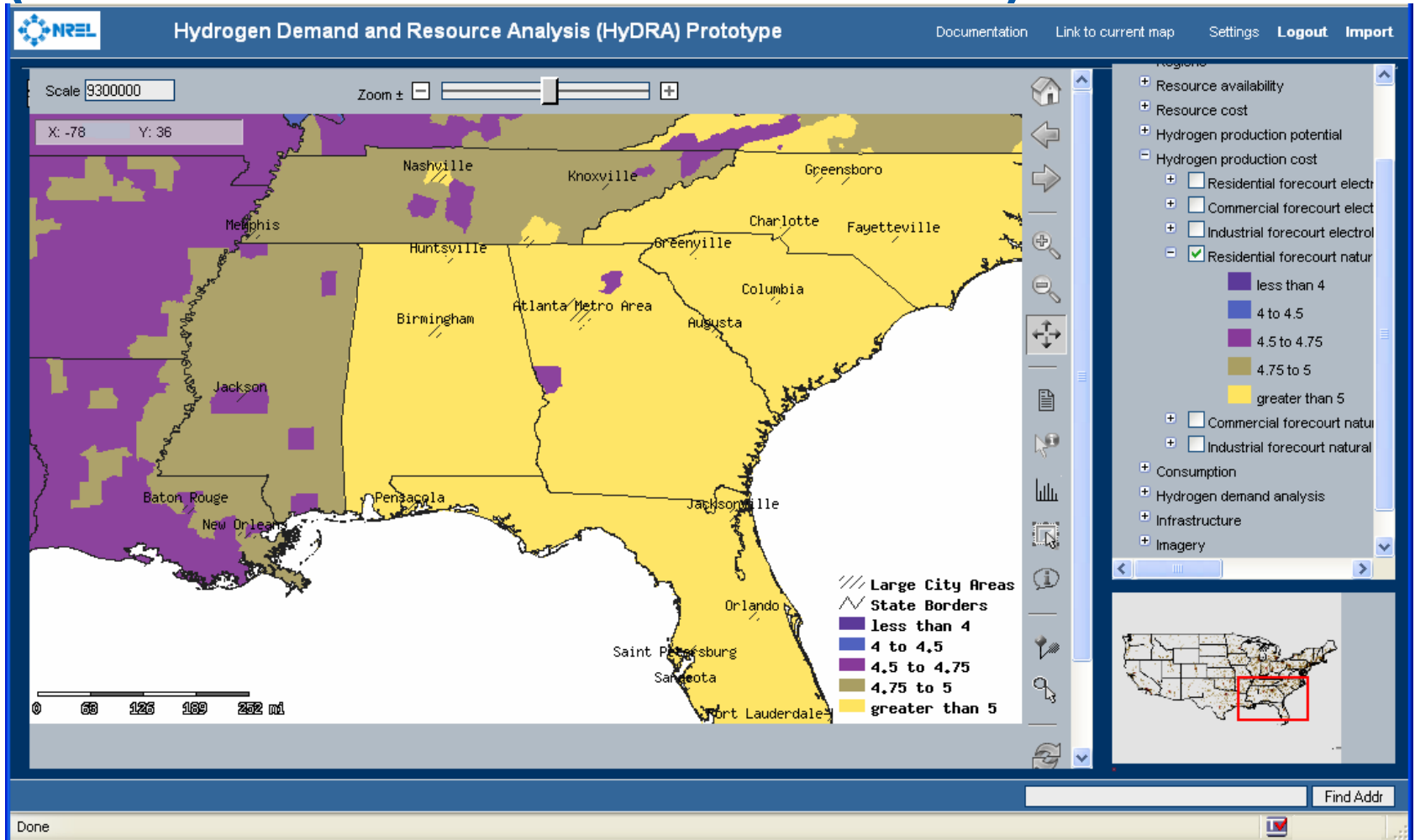
Accomplishments – Natural Gas Cost



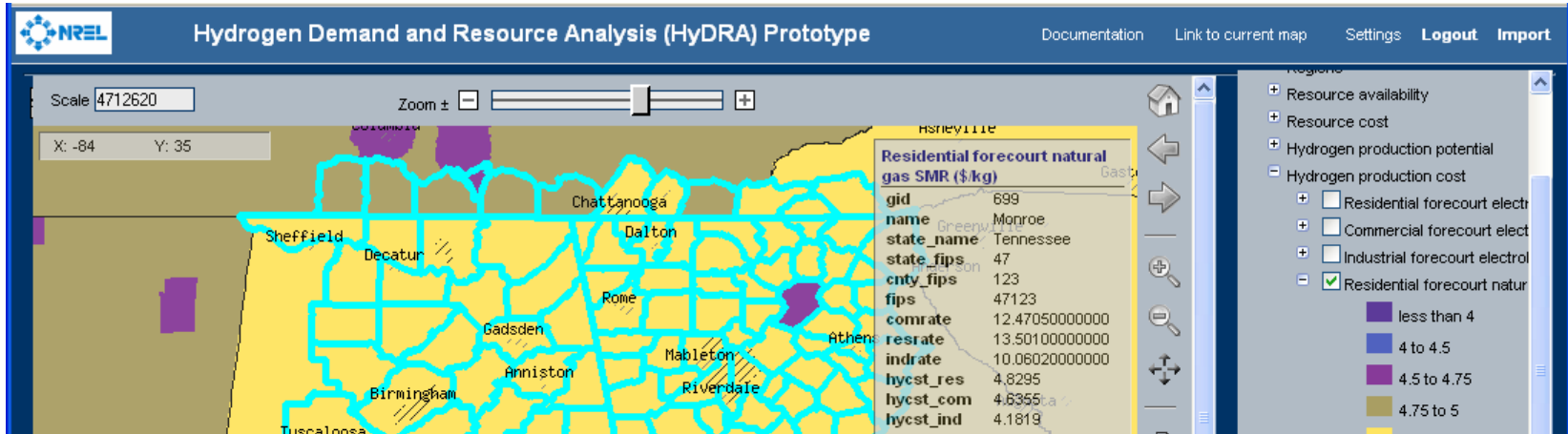
Accomplishments – Natural Gas Cost



Accomplishments – Hydrogen Production Cost (Forecourt SMR from Natural Gas)



Accomplishments – Hydrogen Production Cost

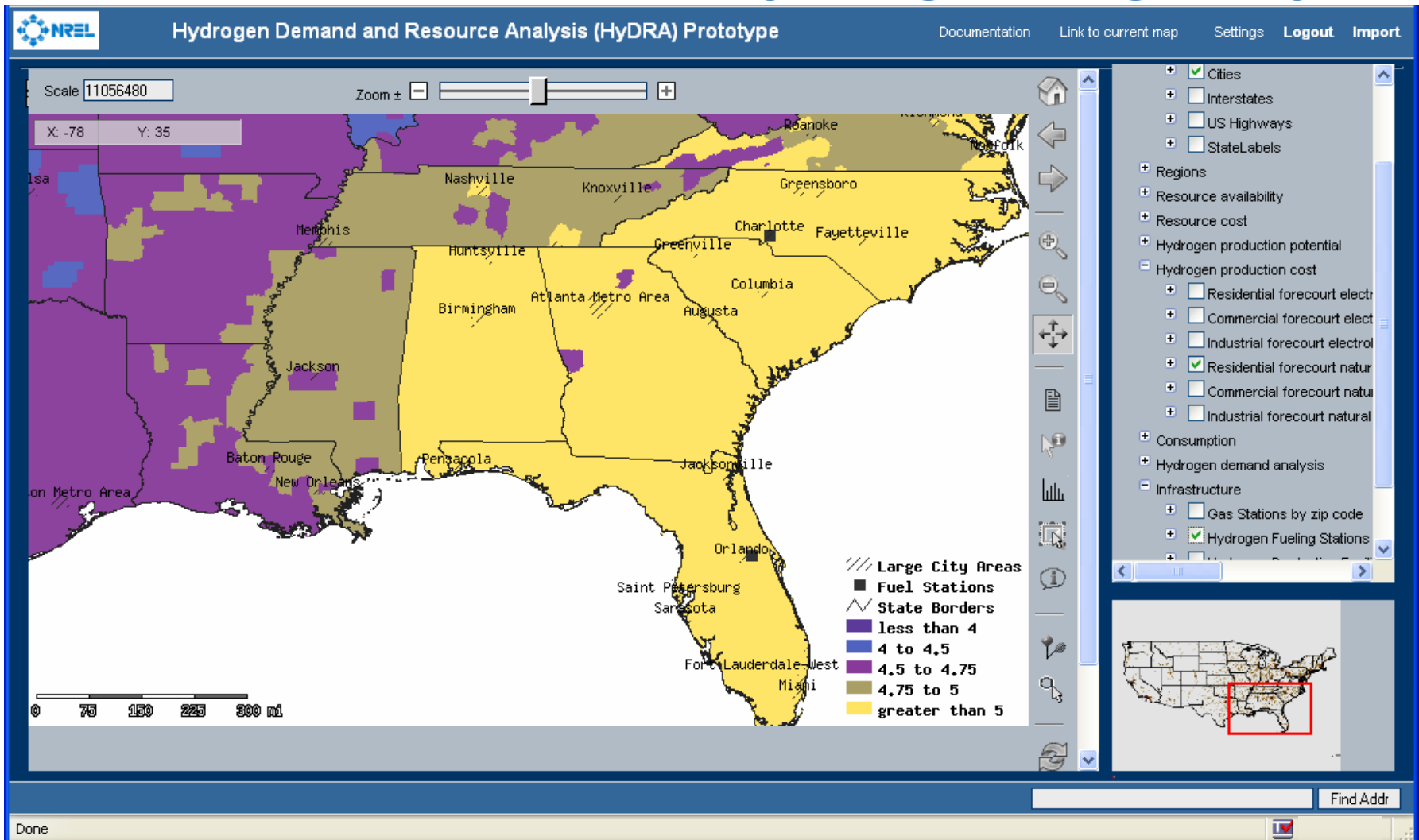


http://rosselli.nrel.gov - Query Results - Mozilla Firefox


Residential forecourt natural gas SMR (\$/kg)

@	gid	name	state_name	state_fips	cnty_fips	fips	comrate	resrate	indrate	hycst_res	hycst_com	hycst_ind
+	683	Blount	Tennessee	47	009	47009	12.385900000000	13.349400000000	10.053800000000	4.801	4.6196	4.1807
+	684	Warren	Tennessee	47	177	47177	12.470000000000	13.500000000000	10.060000000000	4.8293	4.6355	4.1819
+	687	Rhea	Tennessee	47	143	47143	12.470000000000	13.500300000000	10.060000000000	4.8294	4.6355	4.1819
+	693	Bledsoe	Tennessee	47	007	47007	12.470100000000	13.501600000000	10.060200000000	4.8296	4.6355	4.1819
+	694	Meigs	Tennessee	47	121	47121	12.470100000000	13.501600000000	10.060200000000	4.8296	4.6355	4.1819
+	696	Marshall	Tennessee	47	117	47117	12.463700000000	13.488800000000	10.059500000000	4.8272	4.6343	4.1818
+	697	Coffee	Tennessee	47	031	47031	12.465500000000	13.491900000000	10.059700000000	4.8278	4.6346	4.1818
+	698	Bedford	Tennessee	47	003	47003	11.946200000000	12.561100000000	10.020500000000	4.6526	4.5369	4.1745
+	699	Monroe	Tennessee	47	123	47123	12.470500000000	13.501000000000	10.060200000000	4.8295	4.6355	4.1819
+	701	McMinn	Tennessee	47	107	47107	12.470000000000	13.501000000000	10.060100000000	4.8295	4.6355	4.1819
+	704	Sequatchie	Tennessee	47	153	47153	12.470000000000	13.500500000000	10.060100000000	4.8294	4.6355	4.1819
+	705	Grundy	Tennessee	47	061	47061	12.470000000000	13.500000000000	10.060000000000	4.8293	4.6355	4.1819
+	708	Hamilton	Tennessee	47	065	47065	12.533900000000	15.427600000000	10.270100000000	5.1921	4.6475	4.2214
+	712	Murray	Tennessee	47	127	47127	11.063700000000	13.500000000000	10.020400000000	4.6500	4.5400	4.1700

Accomplishments – Hydrogen Highway

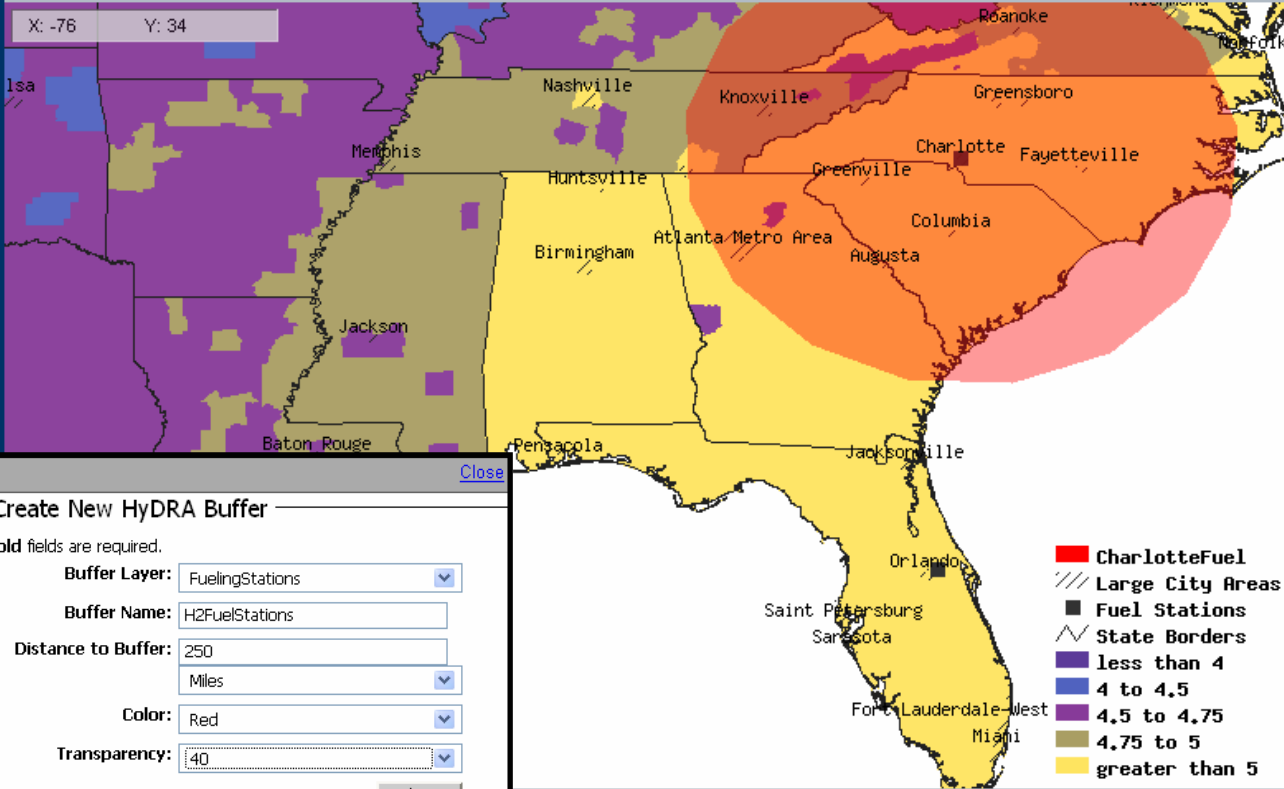


Accomplishments – Hydrogen Highway


Hydrogen Demand and Resource Analysis (HyDRA) Prototype
Documentation [Link to current map](#) Settings [Logout](#) [Import](#)

Scale: 11056480 Zoom ±

X: -76 Y: 34



Create New HyDRA Buffer [Close](#)

Bold fields are required.

Buffer Layer:

Buffer Name:

Distance to Buffer: Miles

Color:

Transparency:

Your Buffer will be created and added to the **User Generated Layers** part of the legend.

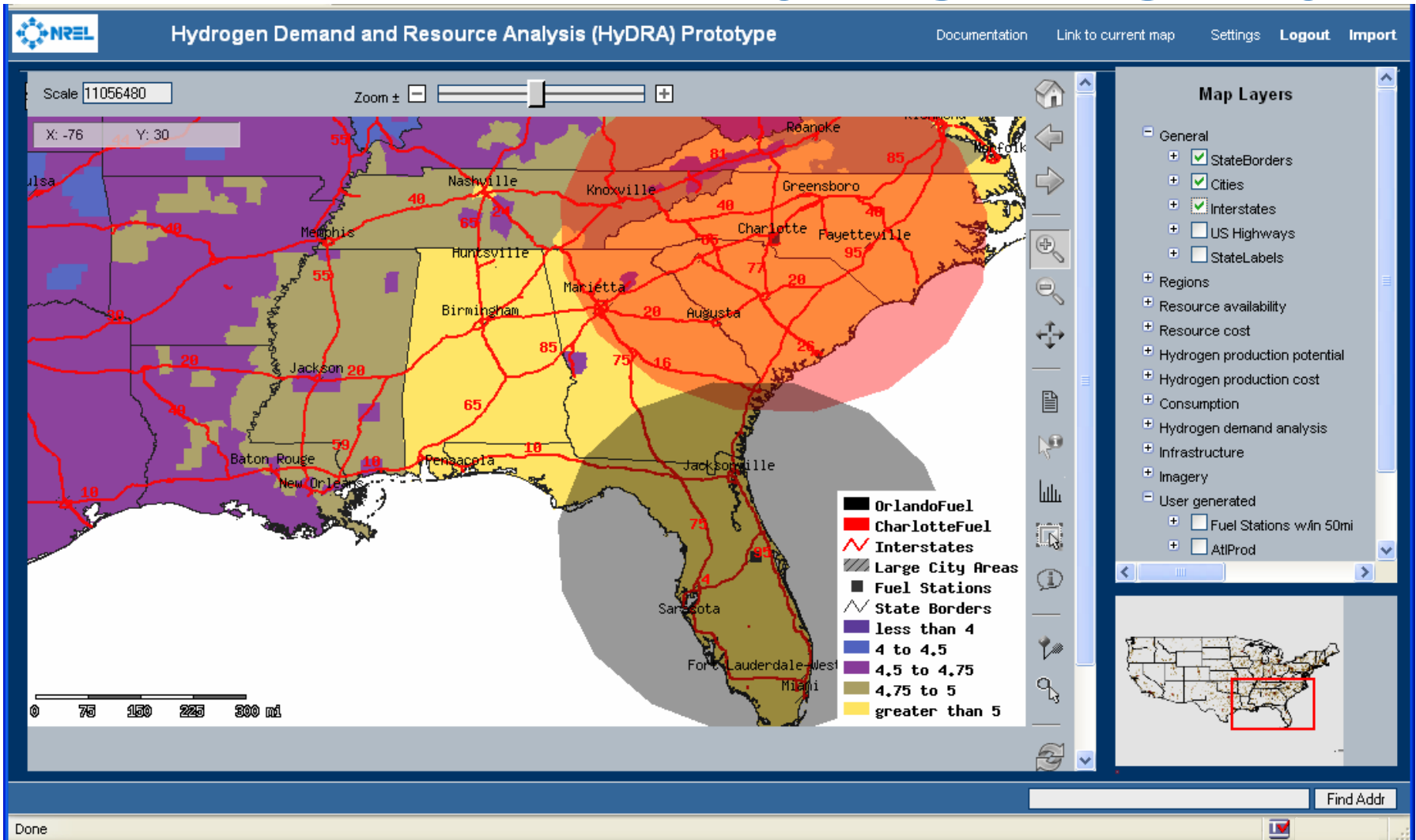
Legend

- CharlotteFuel
- Large City Areas
- Fuel Stations
- State Borders
- less than 4
- 4 to 4.5
- 4.5 to 4.75
- 4.75 to 5
- greater than 5

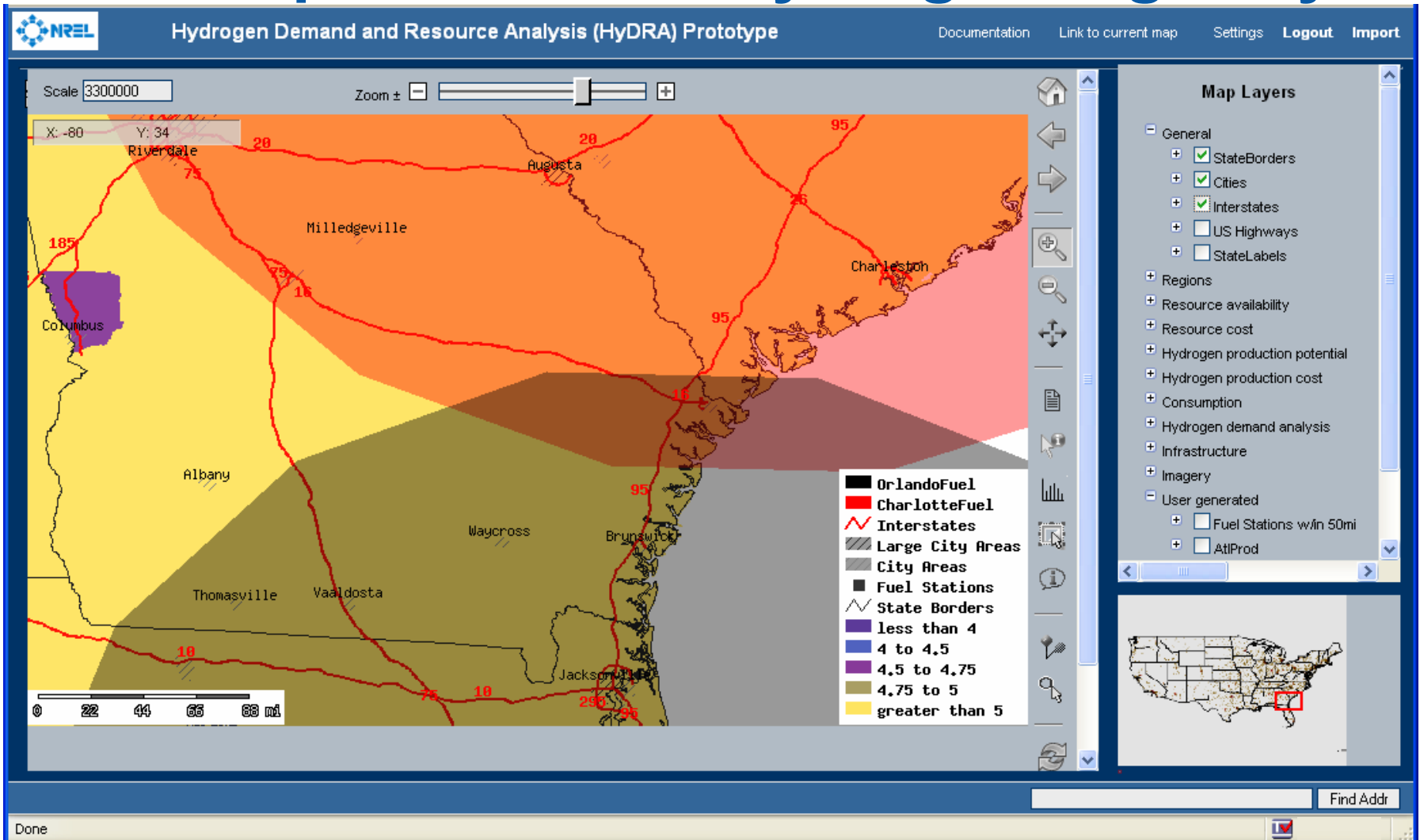
Layers

- Residential forecourt elect
- Commercial forecourt elect
- Industrial forecourt electrol
- Residential forecourt natur
- less than 4
- 4 to 4.5
- 4.5 to 4.75
- 4.75 to 5
- greater than 5
- Commercial forecourt natur
- Industrial forecourt natur
- Consumption
- Hydrogen demand analysis
- Infrastructure
- Imagery
- User generated
 - Fuel Stations w/in 50mi
 - AtIProd
 - Offshorewind
 - CharlotteFuel

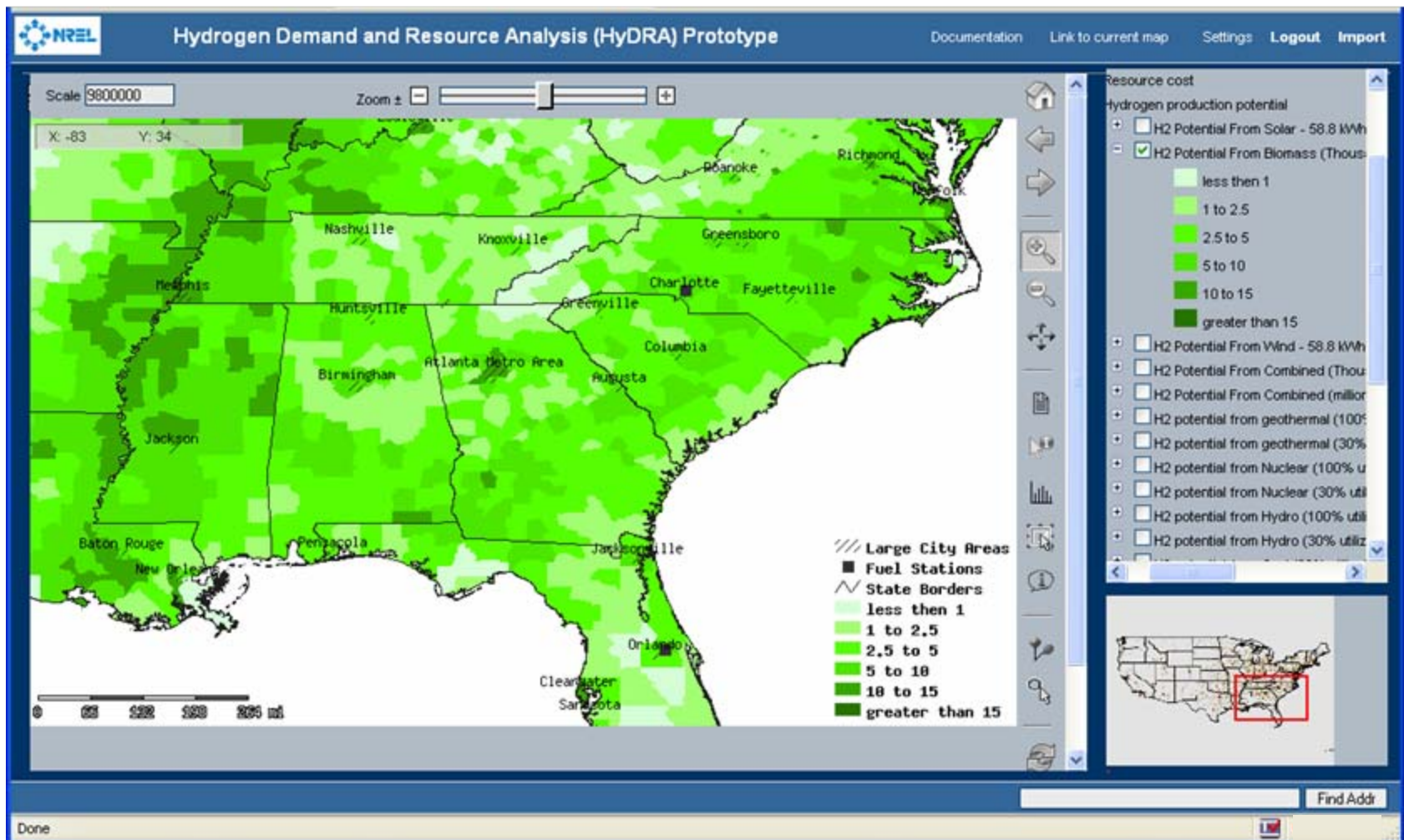
Accomplishments – Hydrogen Highway



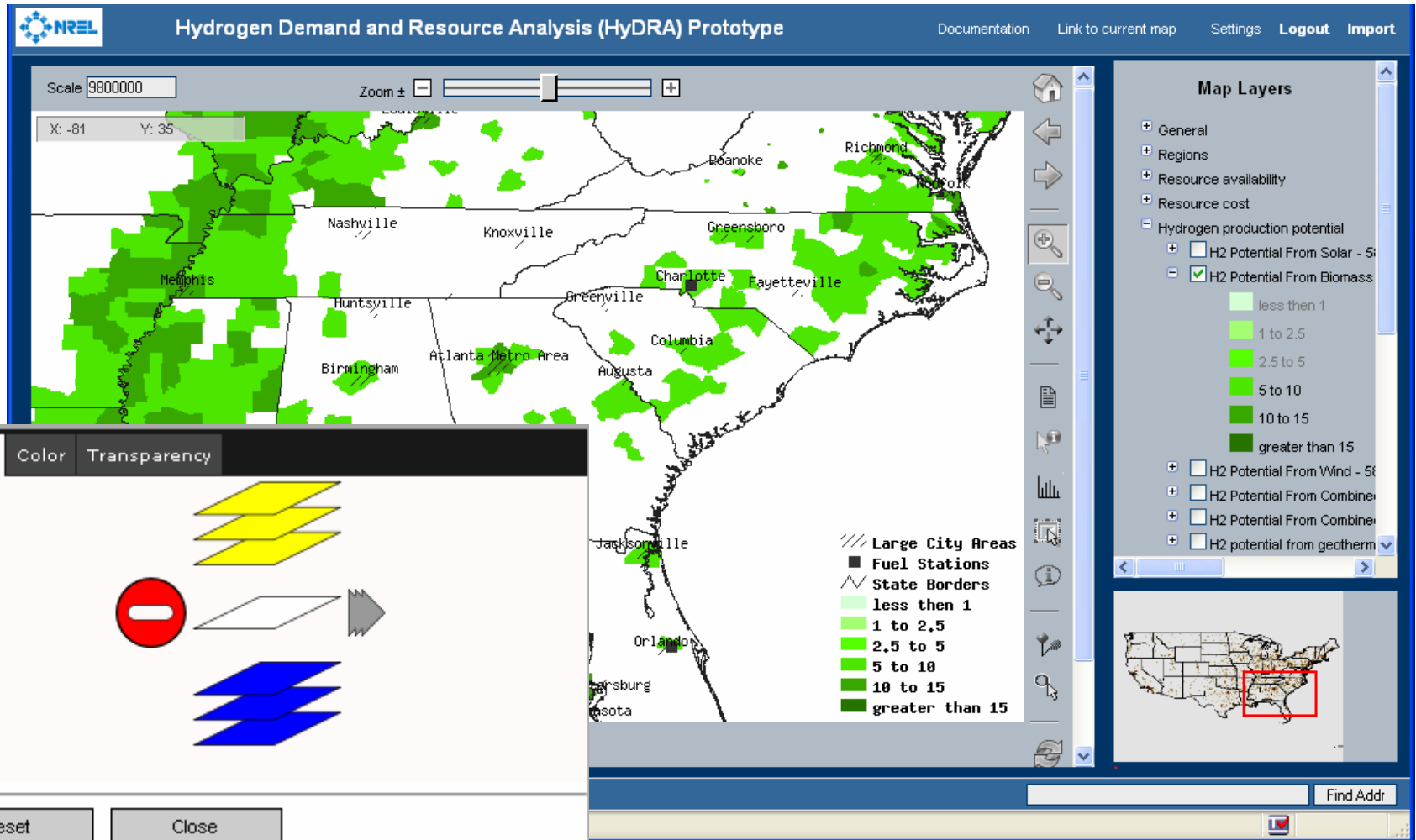
Accomplishments – Hydrogen Highway



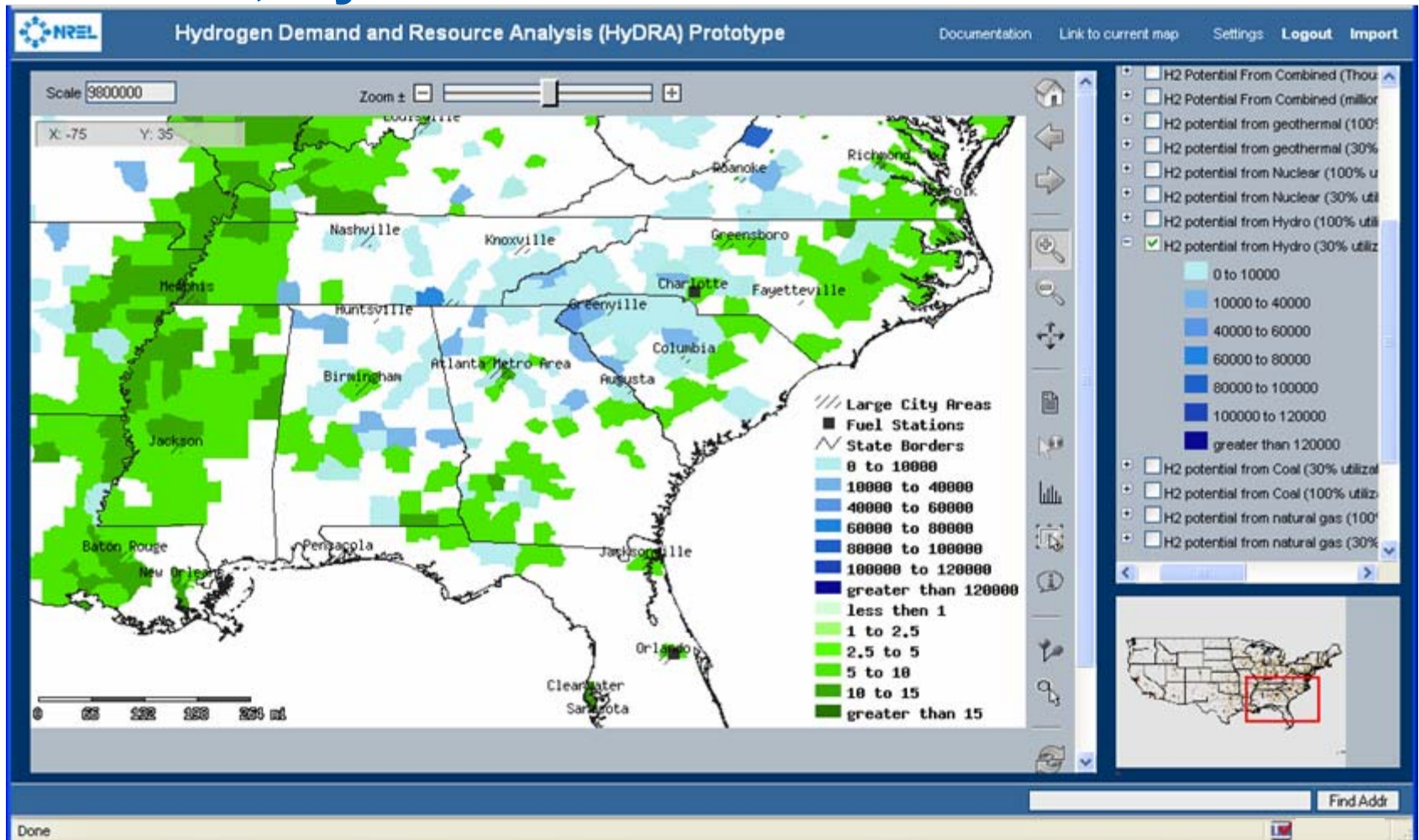
Accomplishments – Hydrogen Production from Biomass



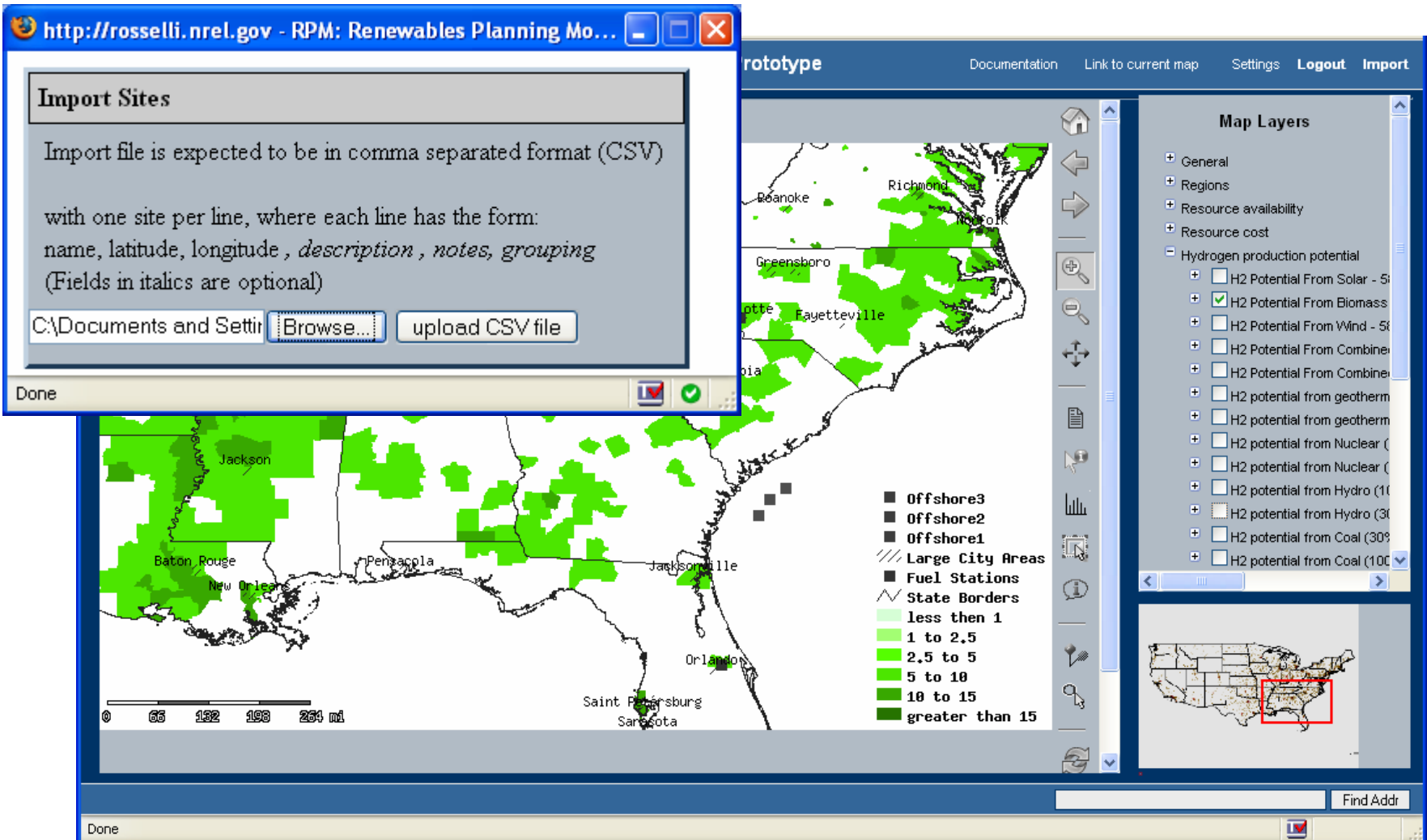
Accomplishments – Hydrogen Production from Biomass



Accomplishments – Hydrogen Production from Biomass, Hydroelectric



Accomplishments – User Data Import



The screenshot displays the RPM: Renewables Planning Model interface. A dialog box titled "Import Sites" is open, providing instructions for importing data in CSV format. The main map shows the Southeastern United States with various regions highlighted in green, representing different resource availability or cost levels. A legend on the right side of the map identifies symbols for Offshore3, Offshore2, Offshore1, Large City Areas, Fuel Stations, and State Borders, as well as color-coded ranges for resource availability (less than 1, 1 to 2.5, 2.5 to 5, 5 to 10, 10 to 15, and greater than 15). The "Map Layers" panel on the right lists various data layers, including "Hydrogen production potential" with sub-layers for different sources like Solar, Biomass, Wind, and Coal.

Import Sites Dialog Box:

Import file is expected to be in comma separated format (CSV)

with one site per line, where each line has the form:
 name, latitude, longitude, *description*, *notes*, *grouping*
 (Fields in italics are optional)

C:\Documents and Settings\... Browse... upload CSV file

Map Legend:

- Offshore3
- Offshore2
- Offshore1
- Large City Areas
- Fuel Stations
- State Borders
- less than 1
- 1 to 2.5
- 2.5 to 5
- 5 to 10
- 10 to 15
- greater than 15

Map Layers Panel:

- General
- Regions
- Resource availability
- Resource cost
- Hydrogen production potential
 - H2 Potential From Solar - 50%
 - H2 Potential From Biomass
 - H2 Potential From Wind - 50%
 - H2 Potential From Combined Cycle
 - H2 Potential From Combined Cycle
 - H2 potential from geothermal
 - H2 potential from geothermal
 - H2 potential from Nuclear (100%)
 - H2 potential from Nuclear (30%)
 - H2 potential from Hydro (100%)
 - H2 potential from Hydro (30%)
 - H2 potential from Coal (30%)
 - H2 potential from Coal (100%)

Future Work – Additional Map Data



In Progress

- Hydrogen Pipelines*
- Oil refineries*
- Power plants*
- Water reservoirs/dams *
- Natural gas pipelines*
- Natural gas storage*
- LNG terminals*
- Electric substations *
- Electric lines *
- Hydrogen producers*

Planned

- Geologic hydrogen storage
- Carbon sequestration
- Rail infrastructure
- Feedstock transportation costs
- Hydrogen transportation costs



*Data restricted to federal employees

Future Work - MSM Integration

Step 1: Manually integrate forecourt SMR and electrolysis costs

County by county analysis

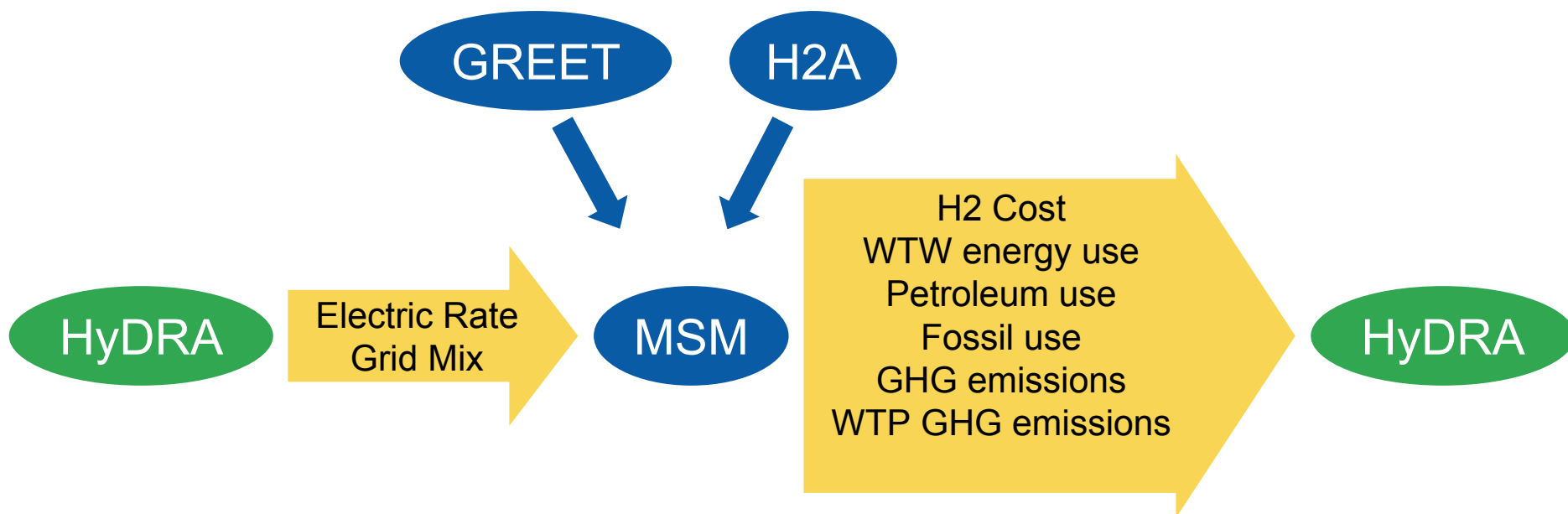
Allows us to validate integration with known results




Step 2: Build new electricity emissions layer for HyDRA

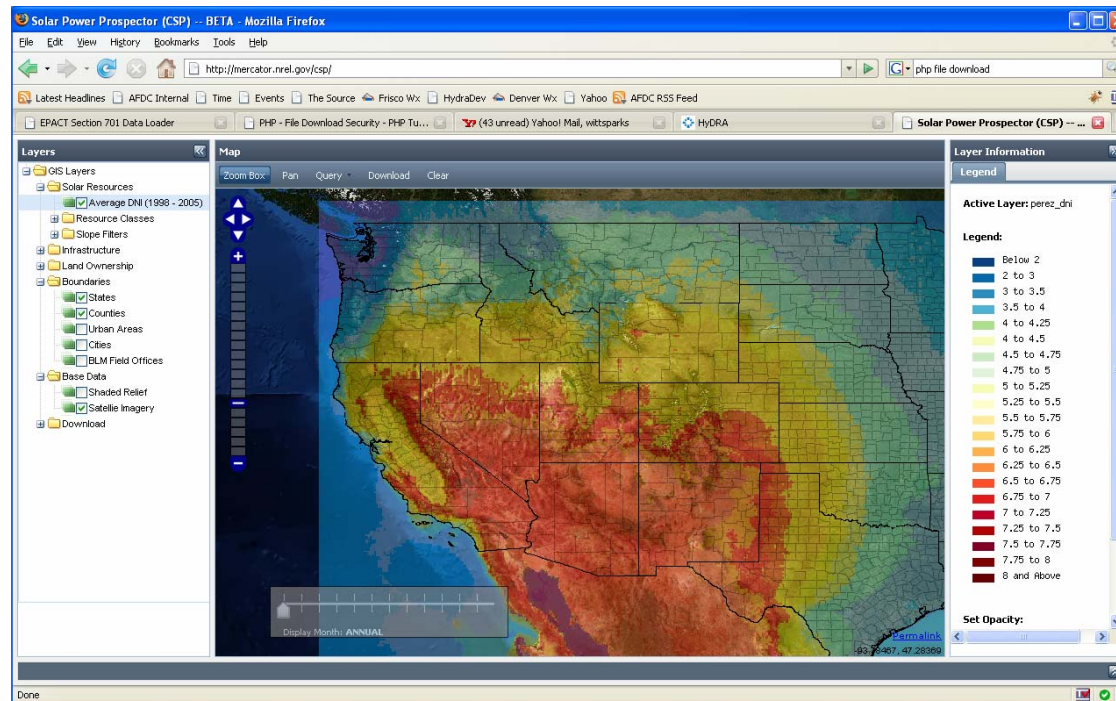
Future Work - MSM Integration

Step 3: Programmatically integrate cost and emissions forecast electrolysis



Future Work – Application Enhancement

- Hydra now has many new features and data layers
 - Responsiveness and usability are becoming more important
 - New technologies are emerging
- 
- Improved look and feel
 - Increased Performance
 - Based on other work being done at NREL



Future Work - Schedule

September 2008:

New content

Initial MSM interface

Re-architecture to improve usability and performance

FY 2009 and beyond:

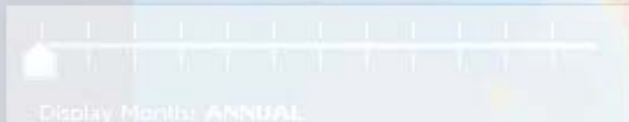
Temporal functionality

Expanded MSM integration

Additional resource and infrastructure layers

Optimization capabilities

Build user base beyond hydrogen



Summary

HyDRA concept is a web-based, dynamic, highly interactive demand and resource tool

- View, download, and report on resource, demand, and infrastructure data
- Spatially represent analysis results
- Provides a tool for regional analysis

Hydra is built on existing work at NREL

- GIS resource analysis
- Hydrogen demand scenario analysis
- Renewable Planning Model

To access the HyDRA application, visit:

<https://rpm.nrel.gov/rpmentry/> and request a login.