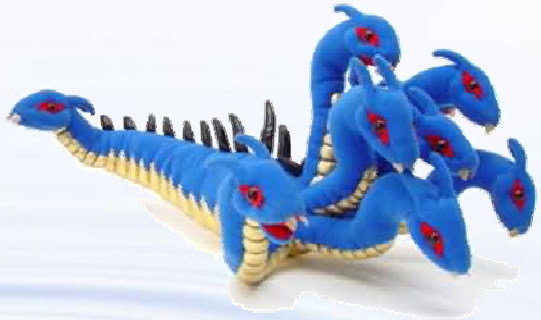
U.S. Department of Energy Hydrogen Program

HyDRA – Hydrogen Demand and Resource Analysis Tool

Presentation to the State and Regional Hydrogen and Fuel Cell Initiatives Call Group

July 2008



Fred Joseck
Technology Analyst

Overview

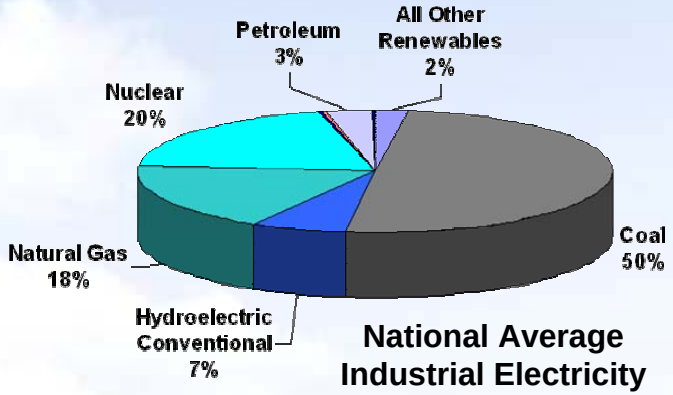
HyDRA is a project performed by NREL as part of the DOE Hydrogen Program's analysis portfolio

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.

Approach

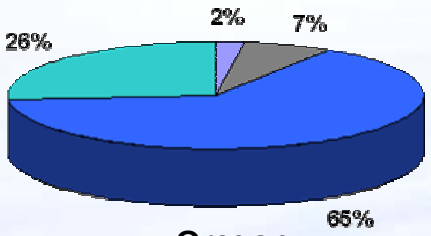
Spatial Analysis for Hydrogen

- Energy carrier
- Produced from various feedstocks

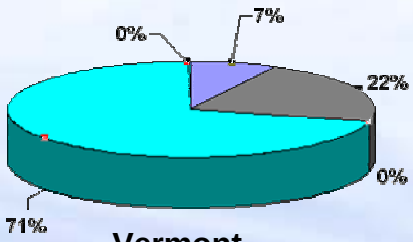


National Average Industrial Electricity Rate = $0.0525/kWh

Resource, Demand, and Infrastructure Vary Regionally



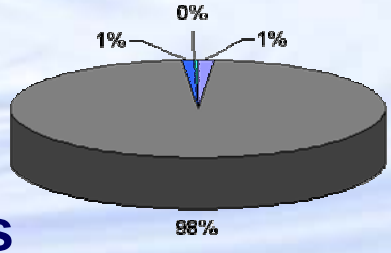
Oregon – $0.0443/kWh



Vermont – $0.0796/kWh

- Move beyond national averages
- Facilitate regional and local analyses

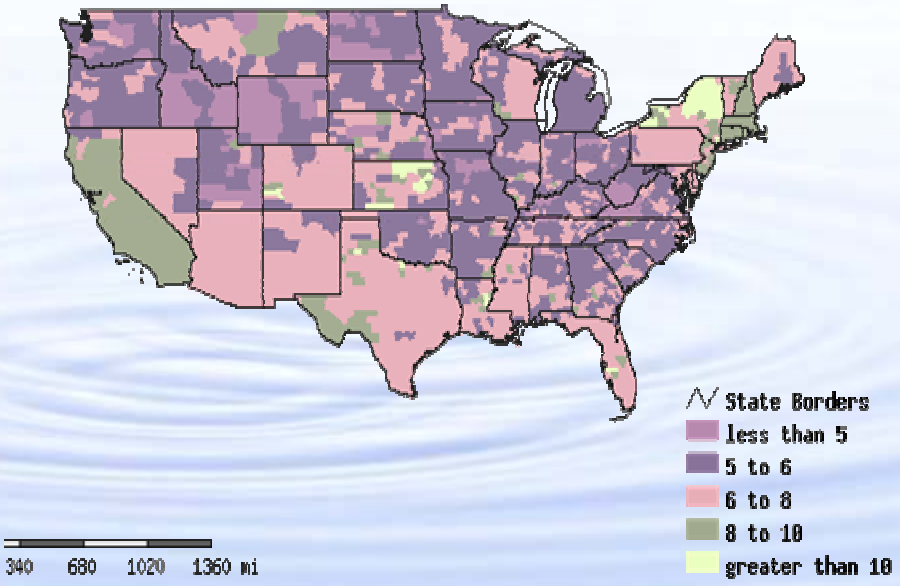
Wyoming – $0.0391/kWh



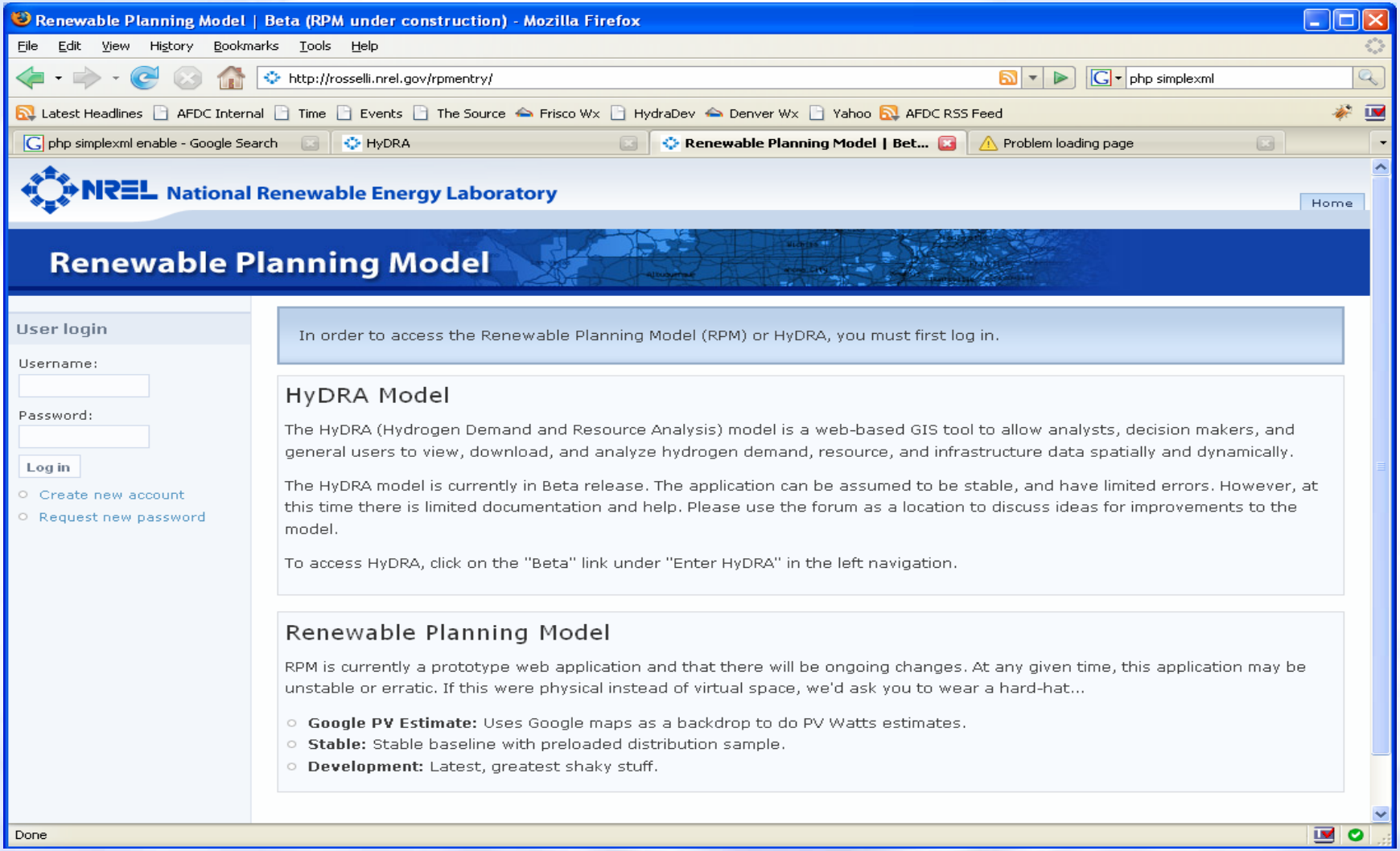
Build on Existing Tools and Models

Overview

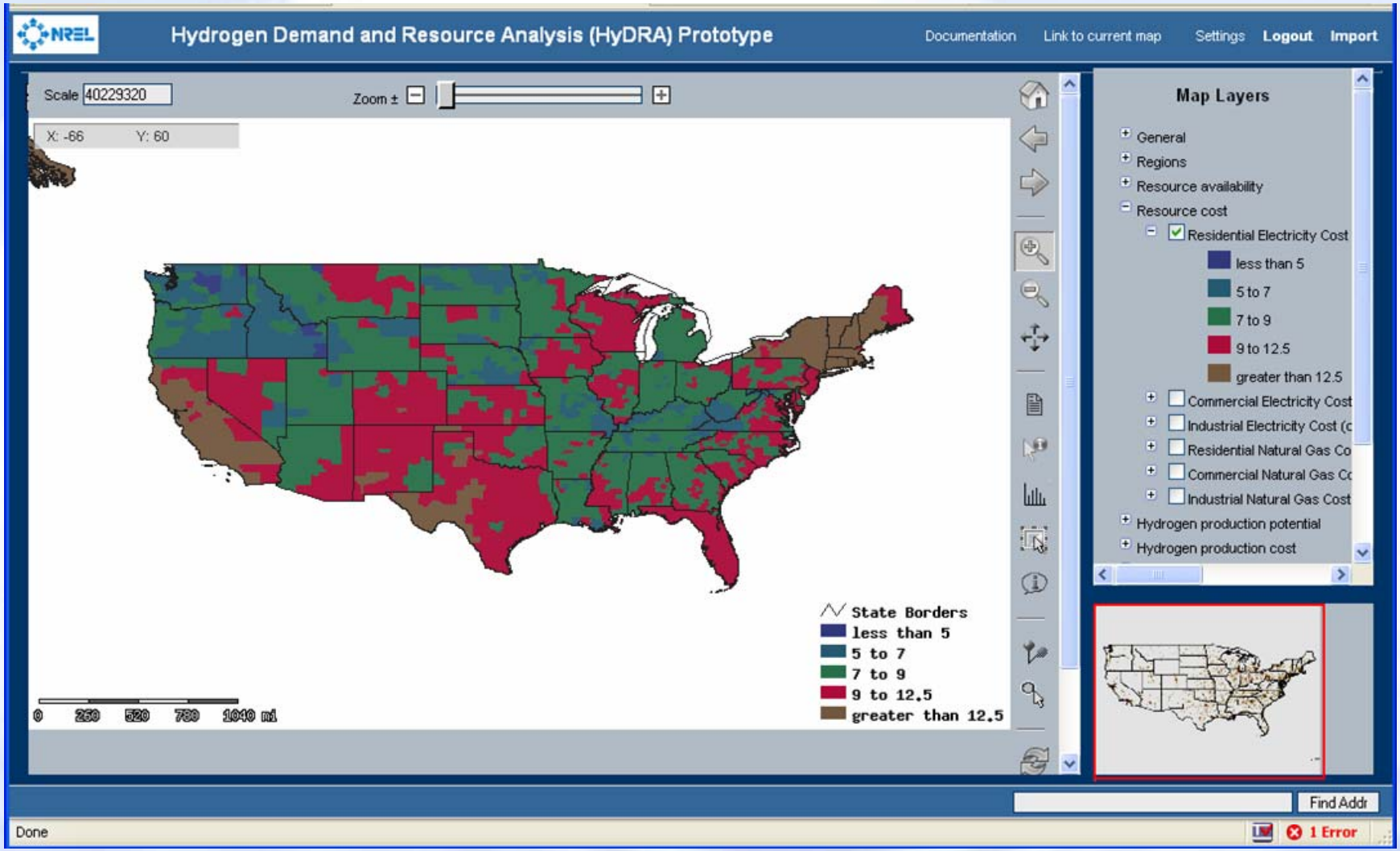
- **48 integrated datasets viewable as graphical maps**
  - ✓Resource cost and availability
  - ✓Hydrogen production cost
  - ✓Resource consumption
  - ✓Hydrogen demand
  - ✓Infrastructure
- **Data manipulation and analysis tools**
- **Application security**



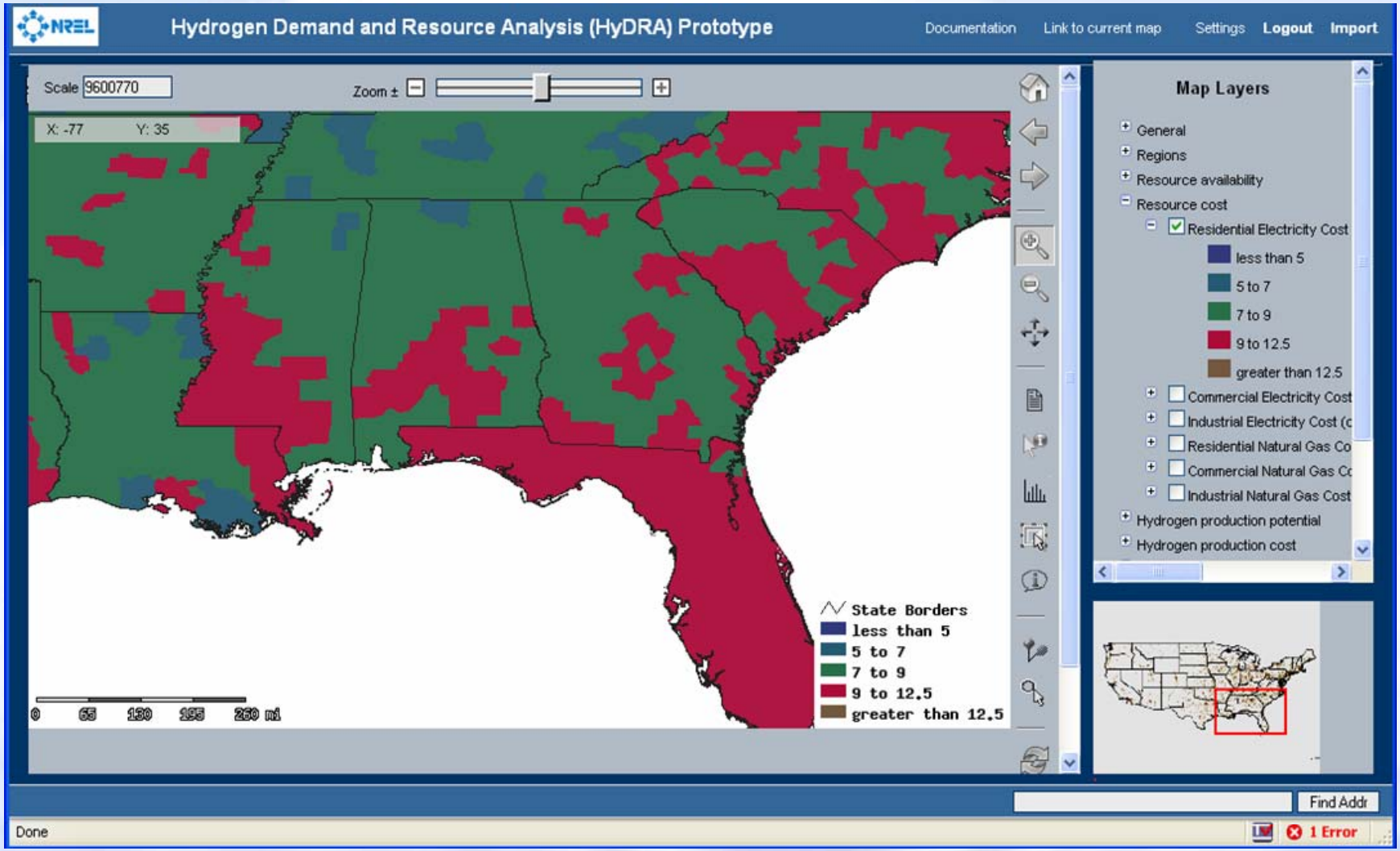
Data Security



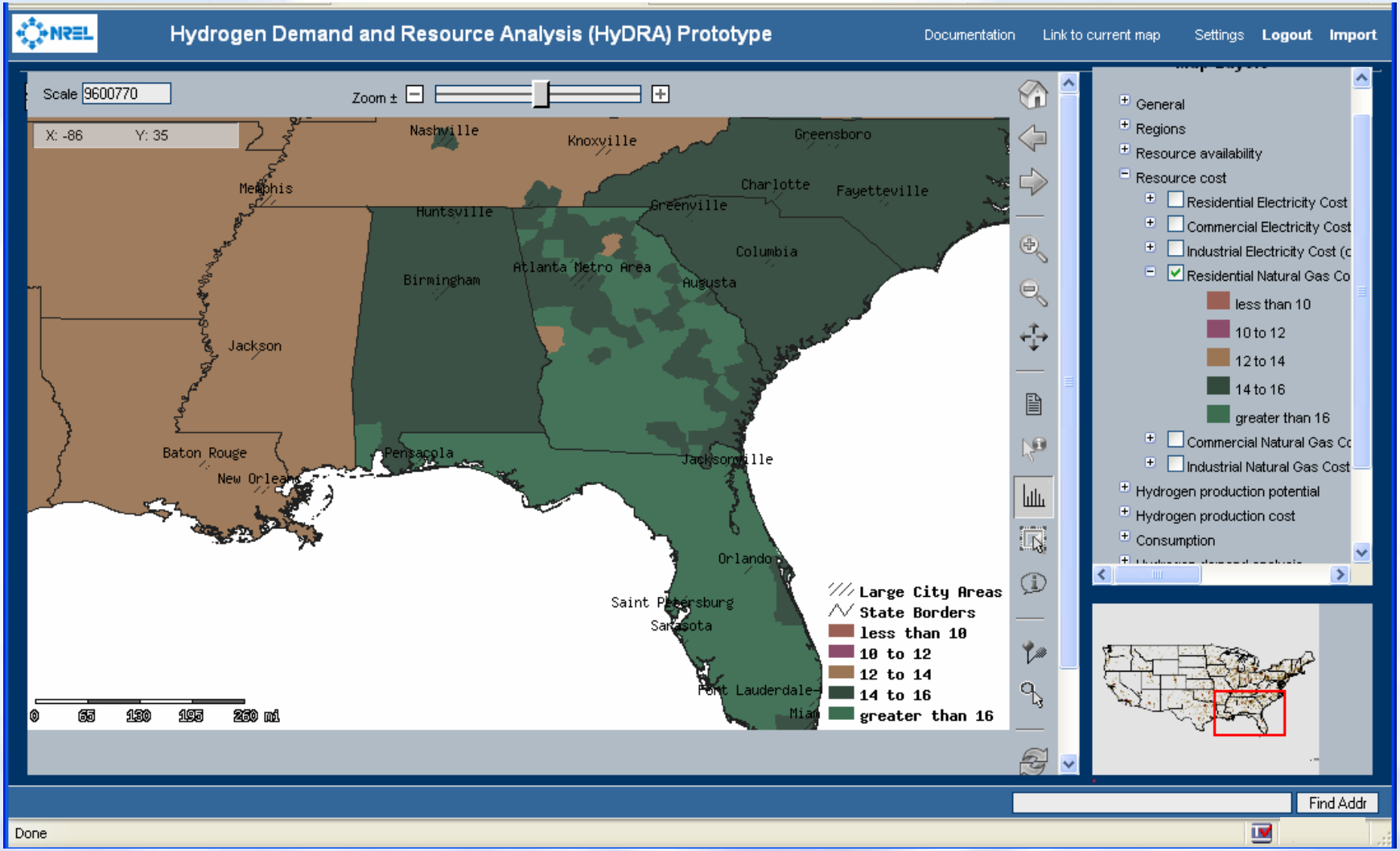
Electricity Cost



Electricity Cost



Natural Gas Cost



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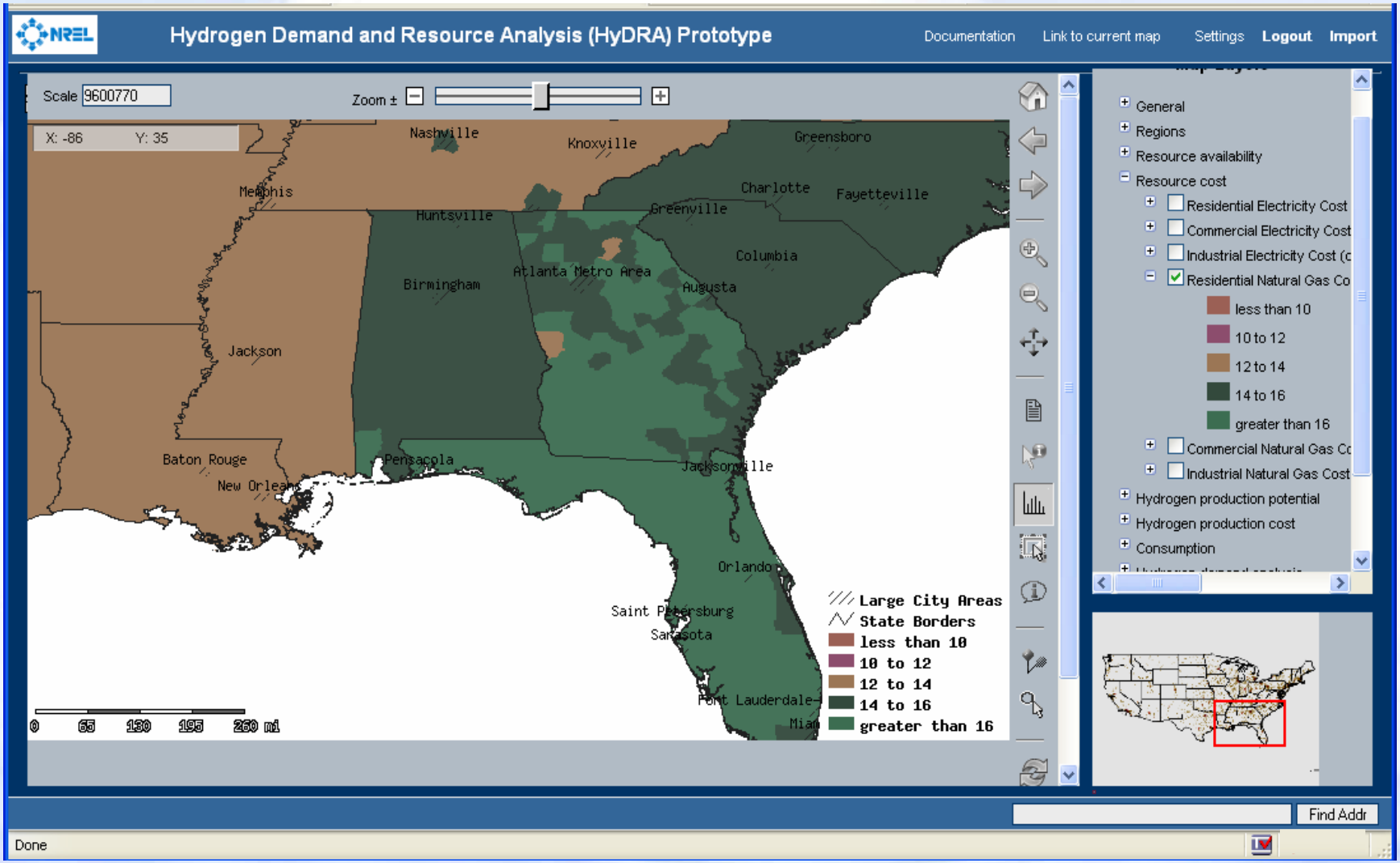
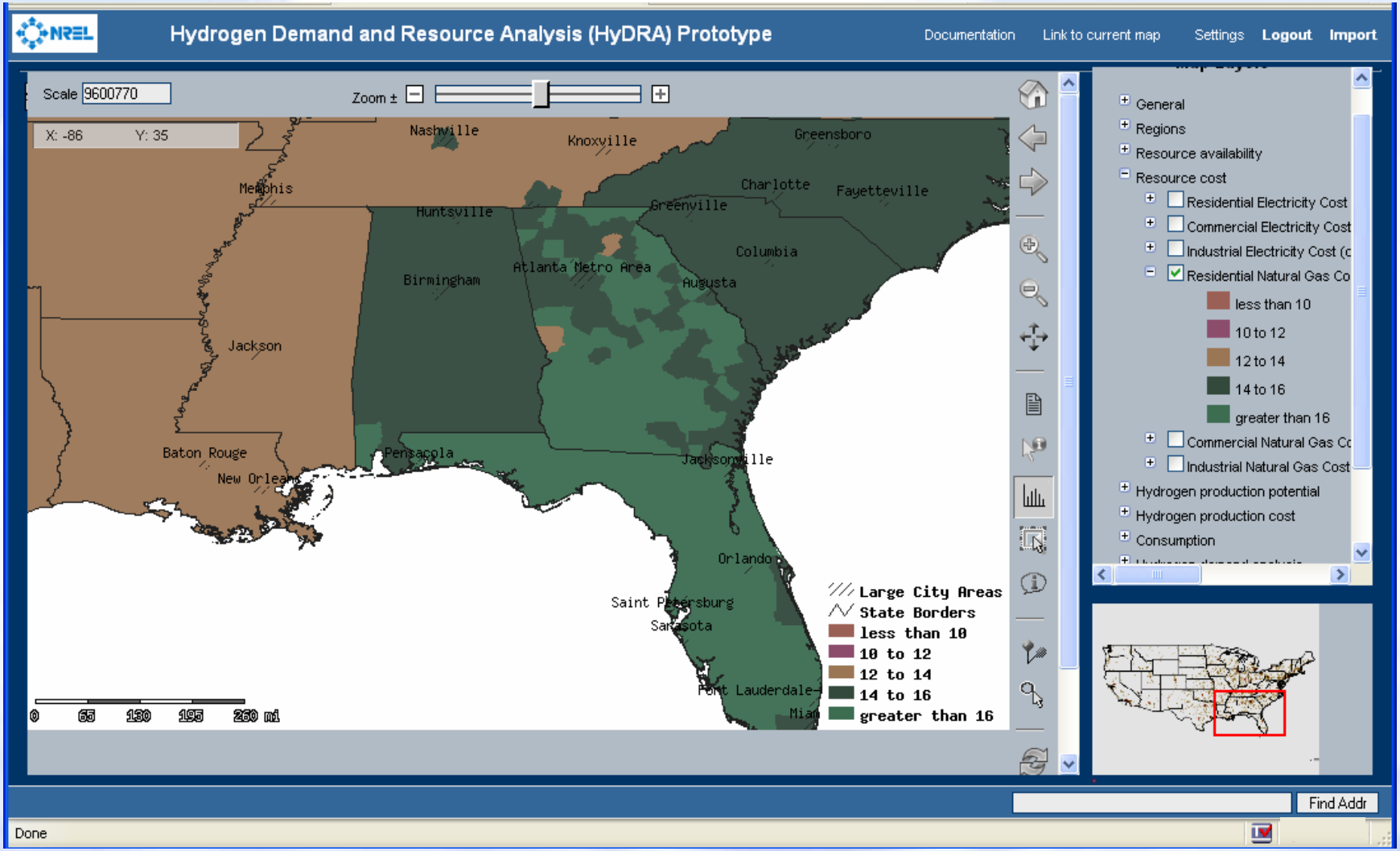
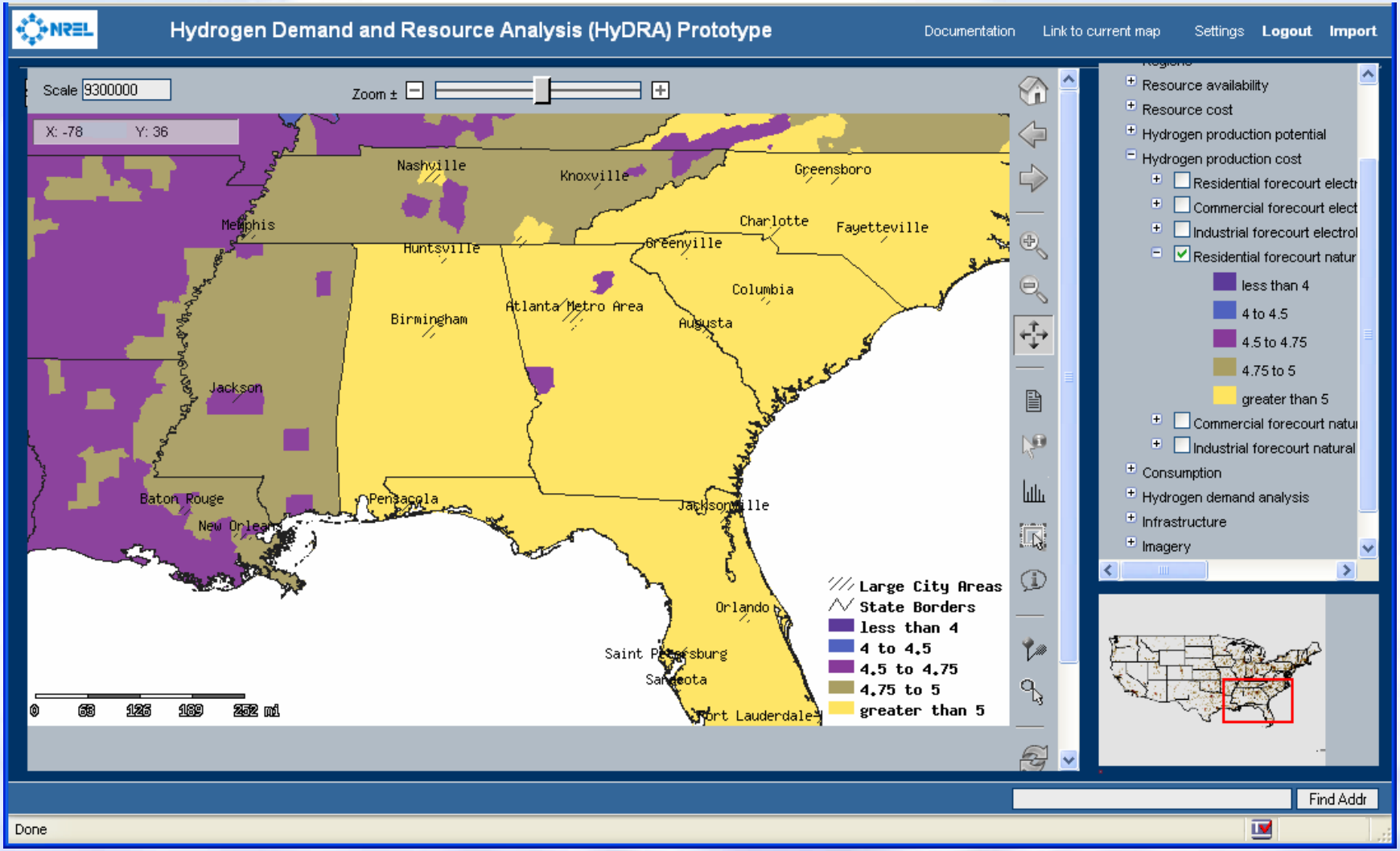


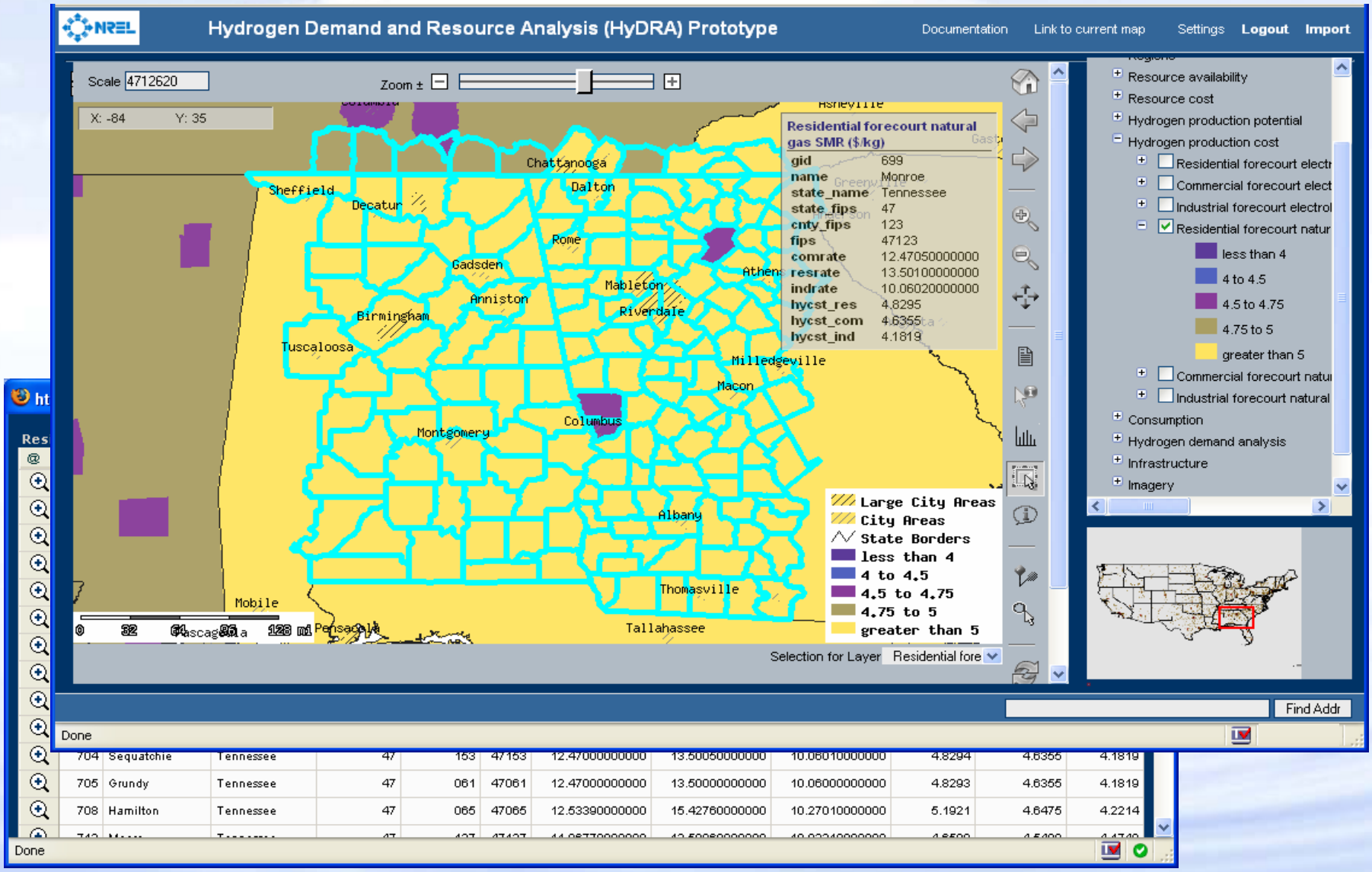
Natural Gas Cost



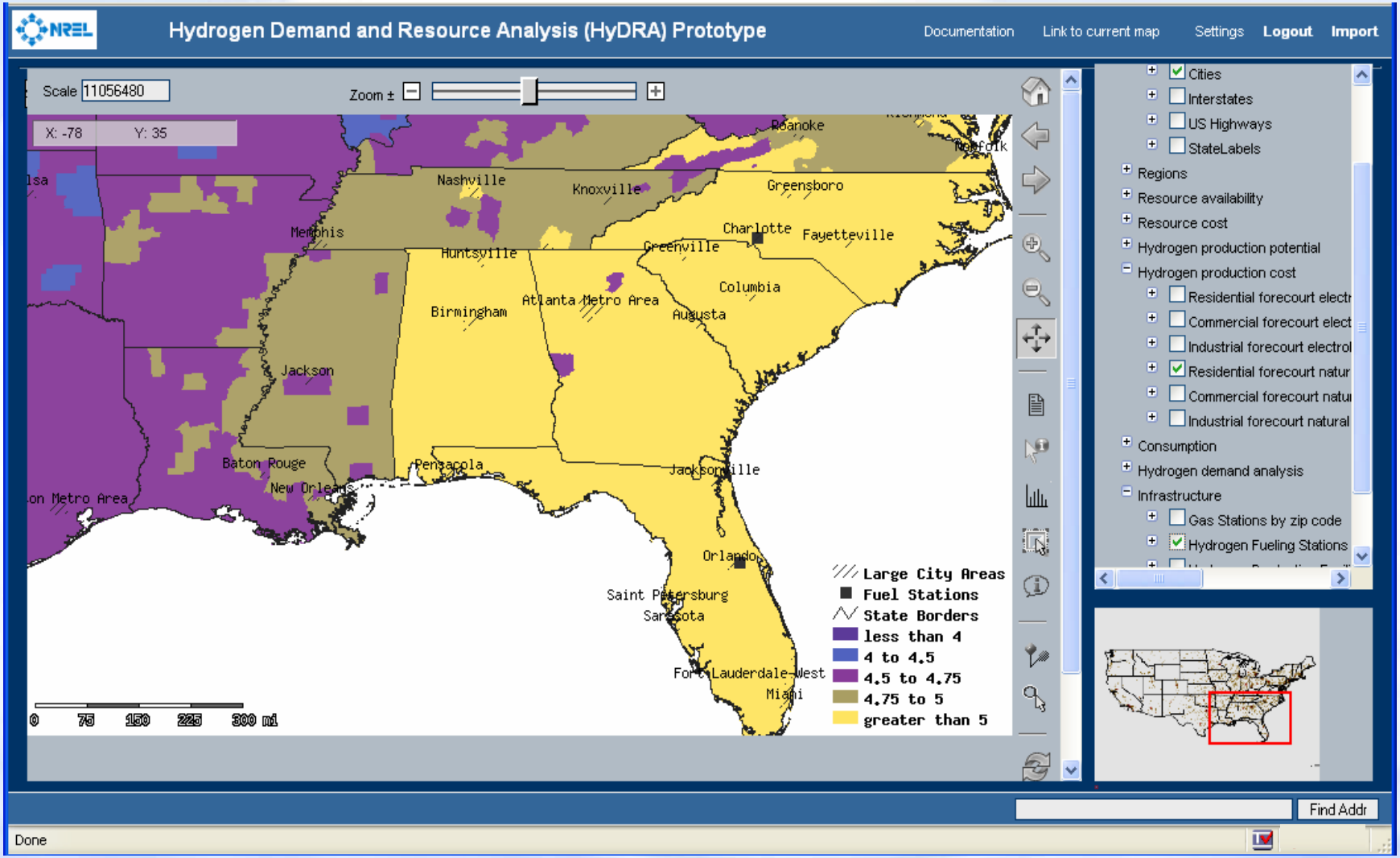
Hydrogen Production Cost
(Forecourt SMR from Natural Gas)



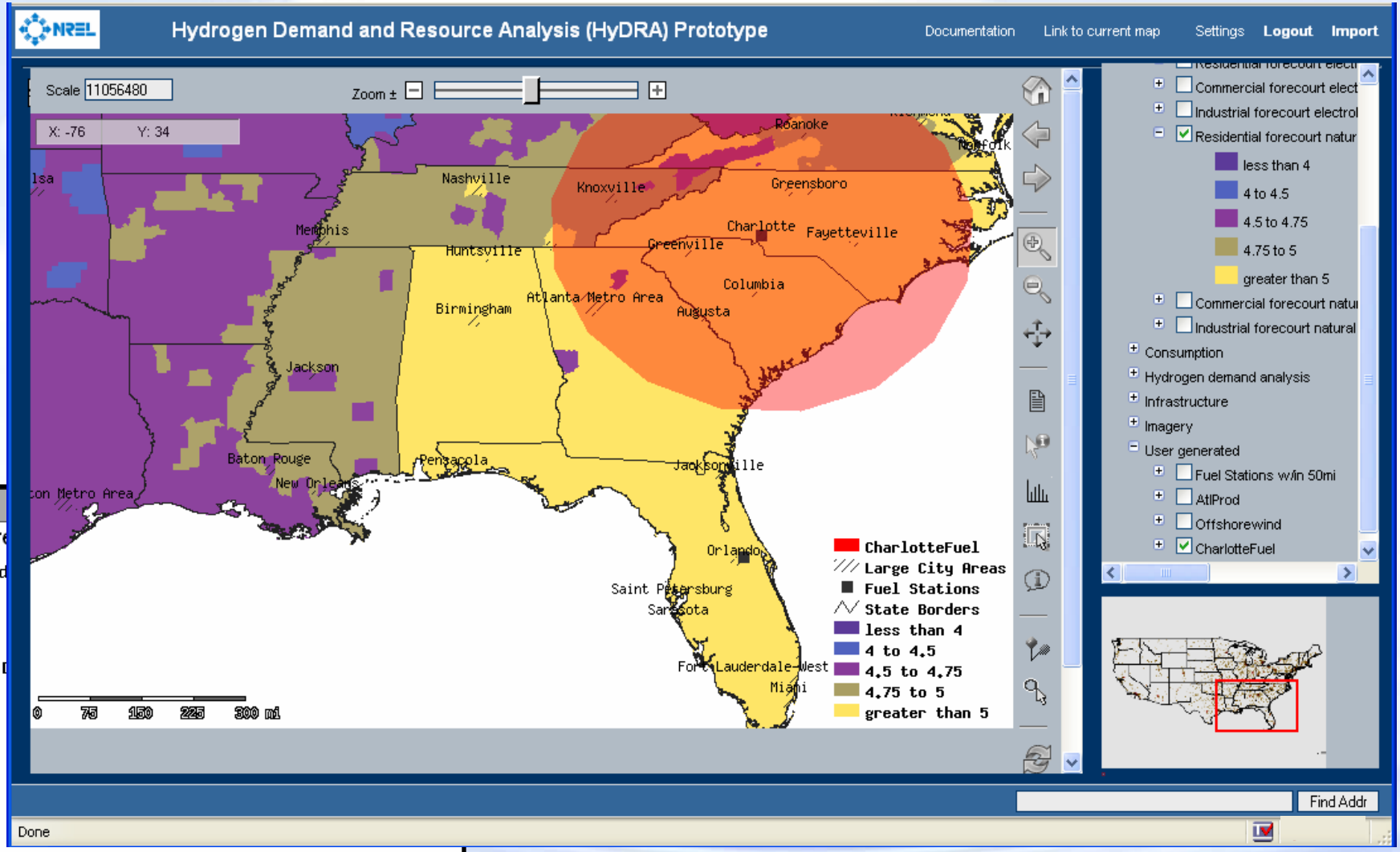
Hydrogen Production Cost



Infrastructure Planning

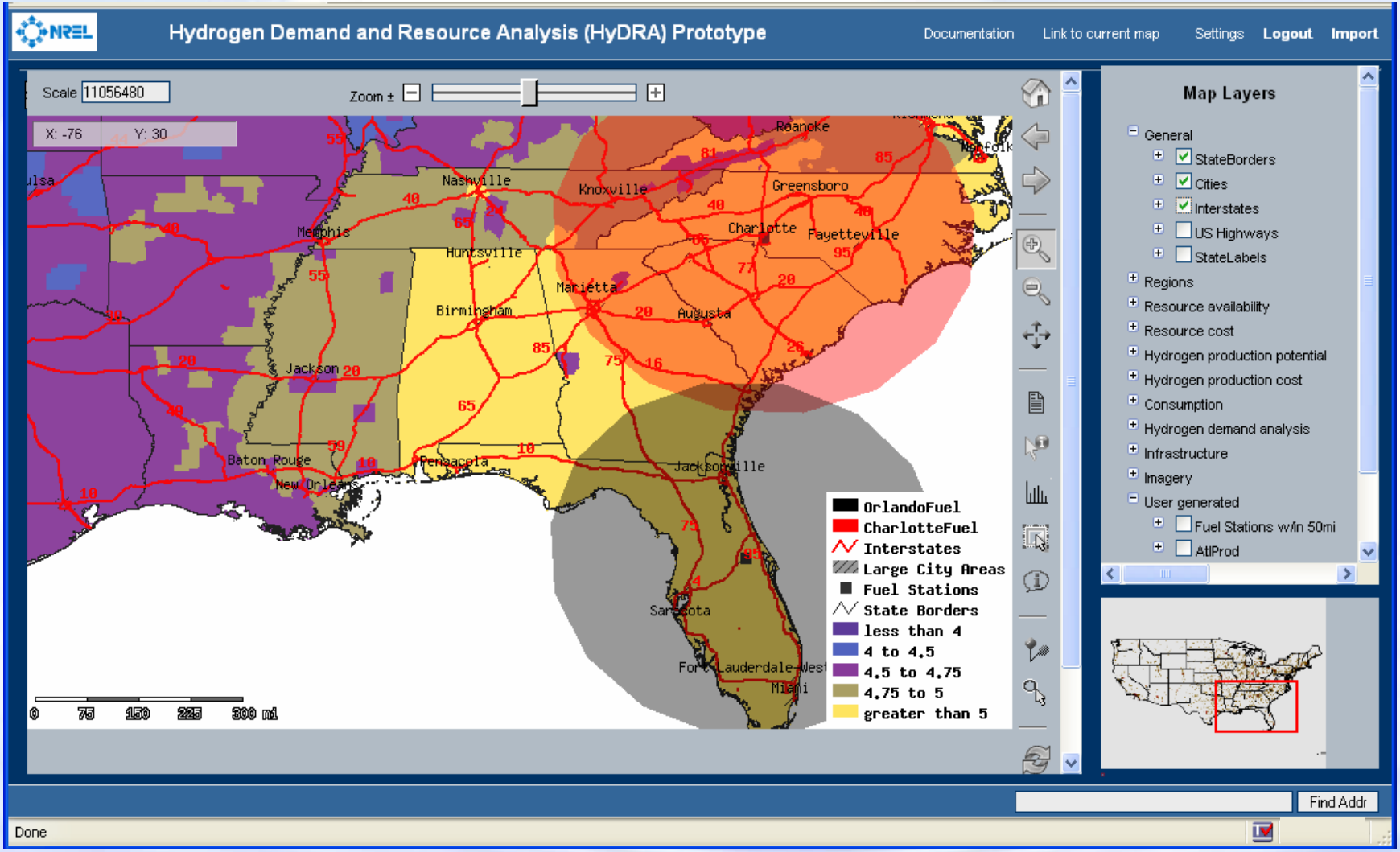


Infrastructure Planning

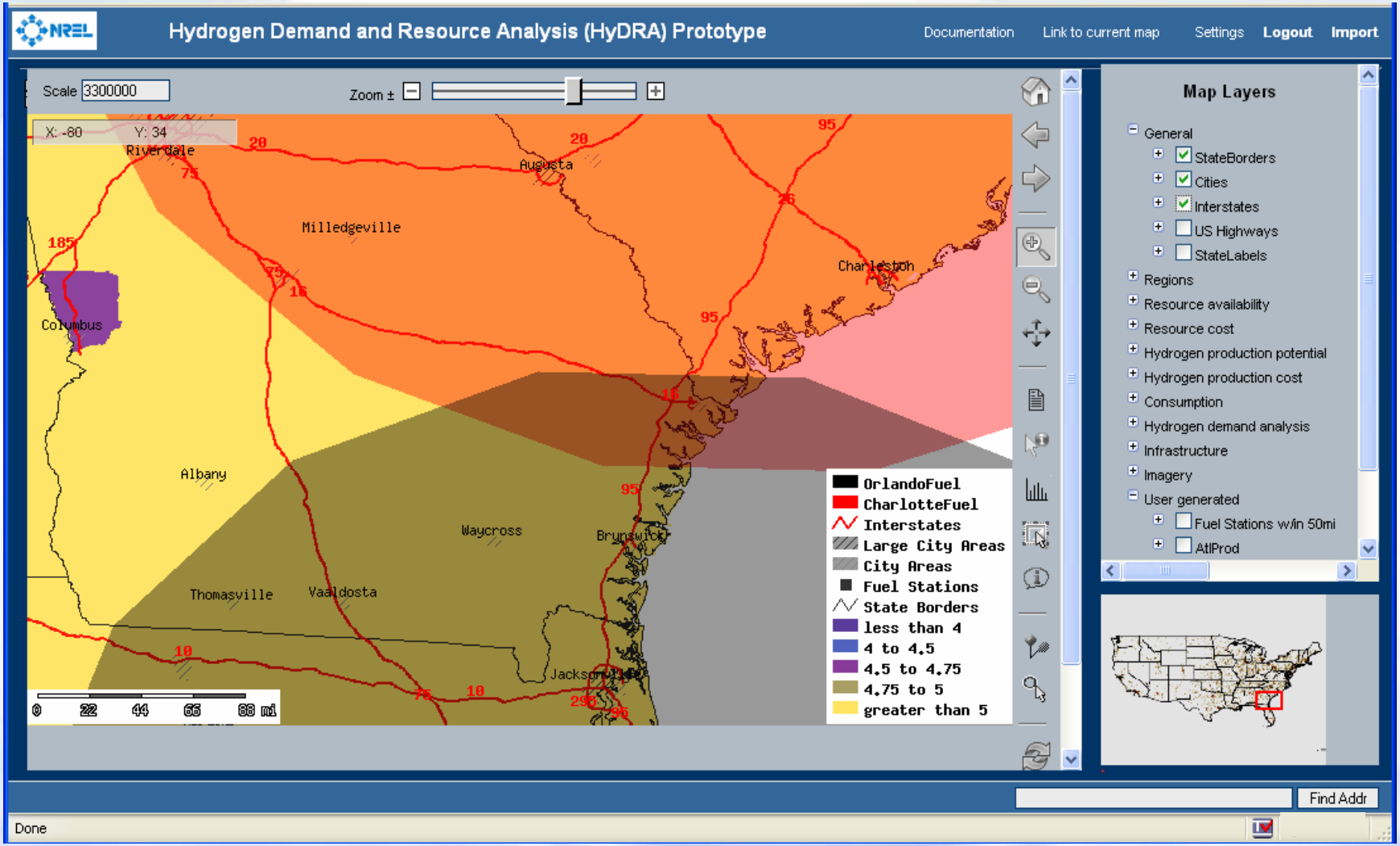


Your Buffer will be created and added to the **User Generated Layers** part of the legend.

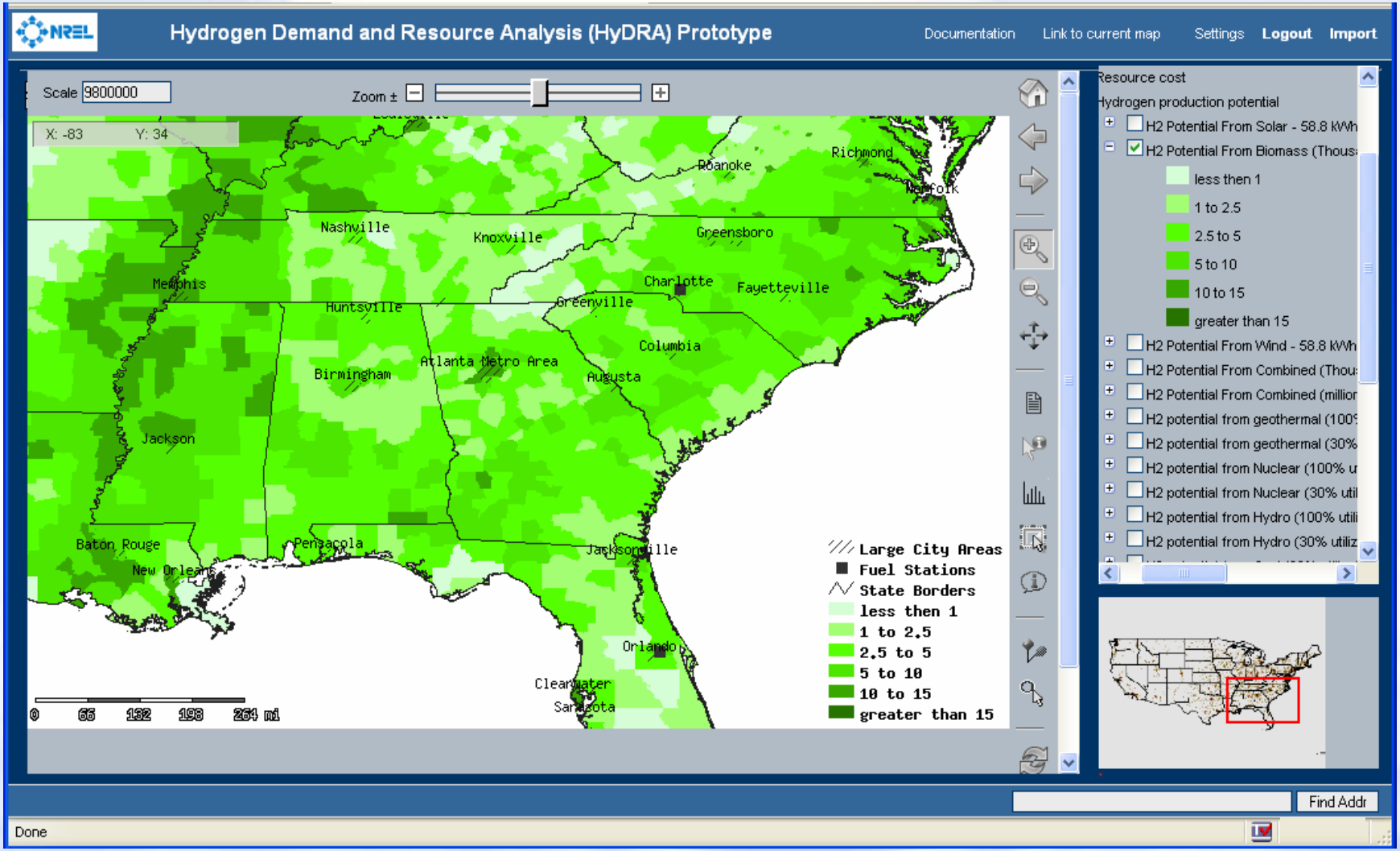
Infrastructure Planning



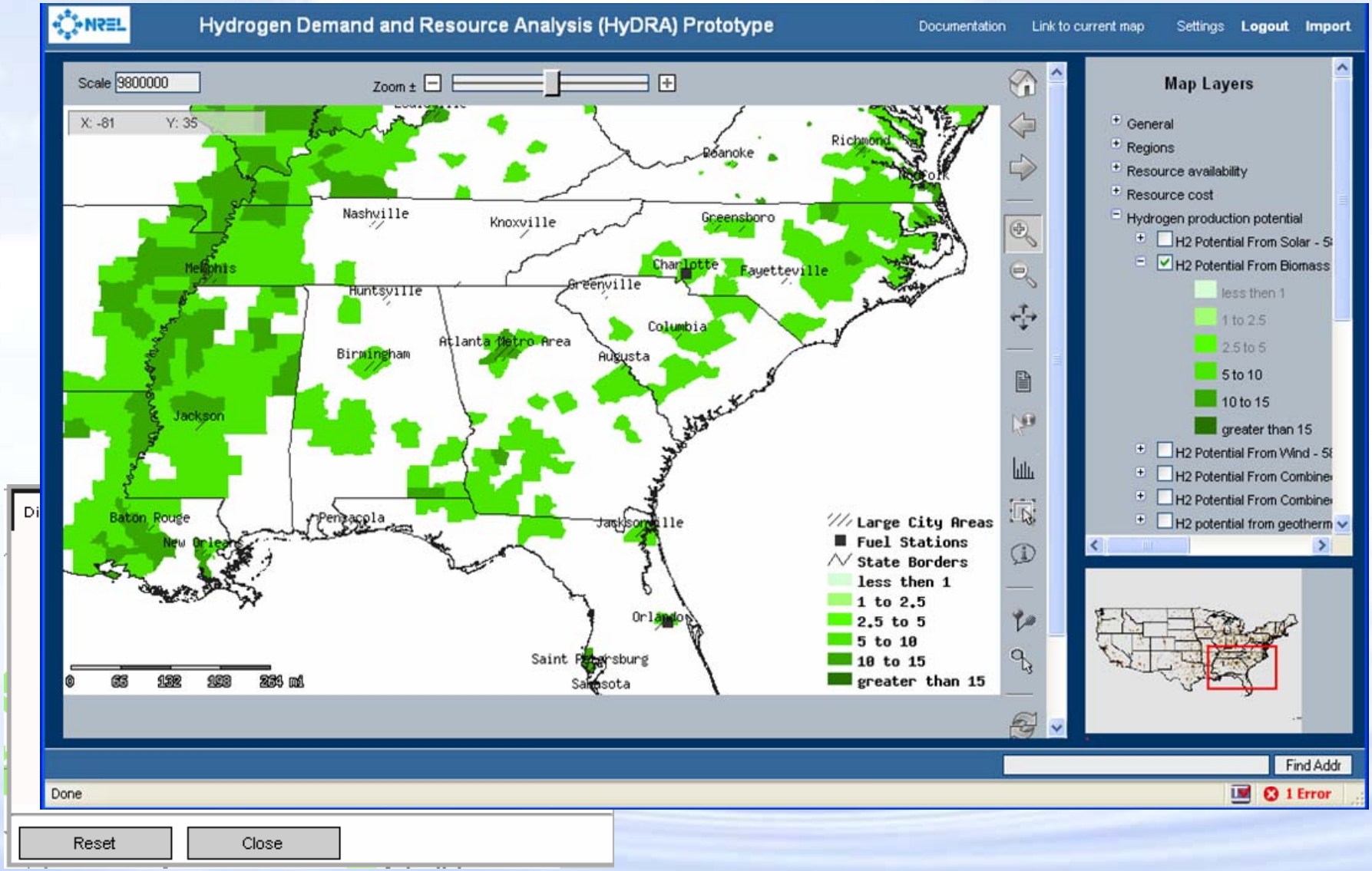
Infrastructure Planning



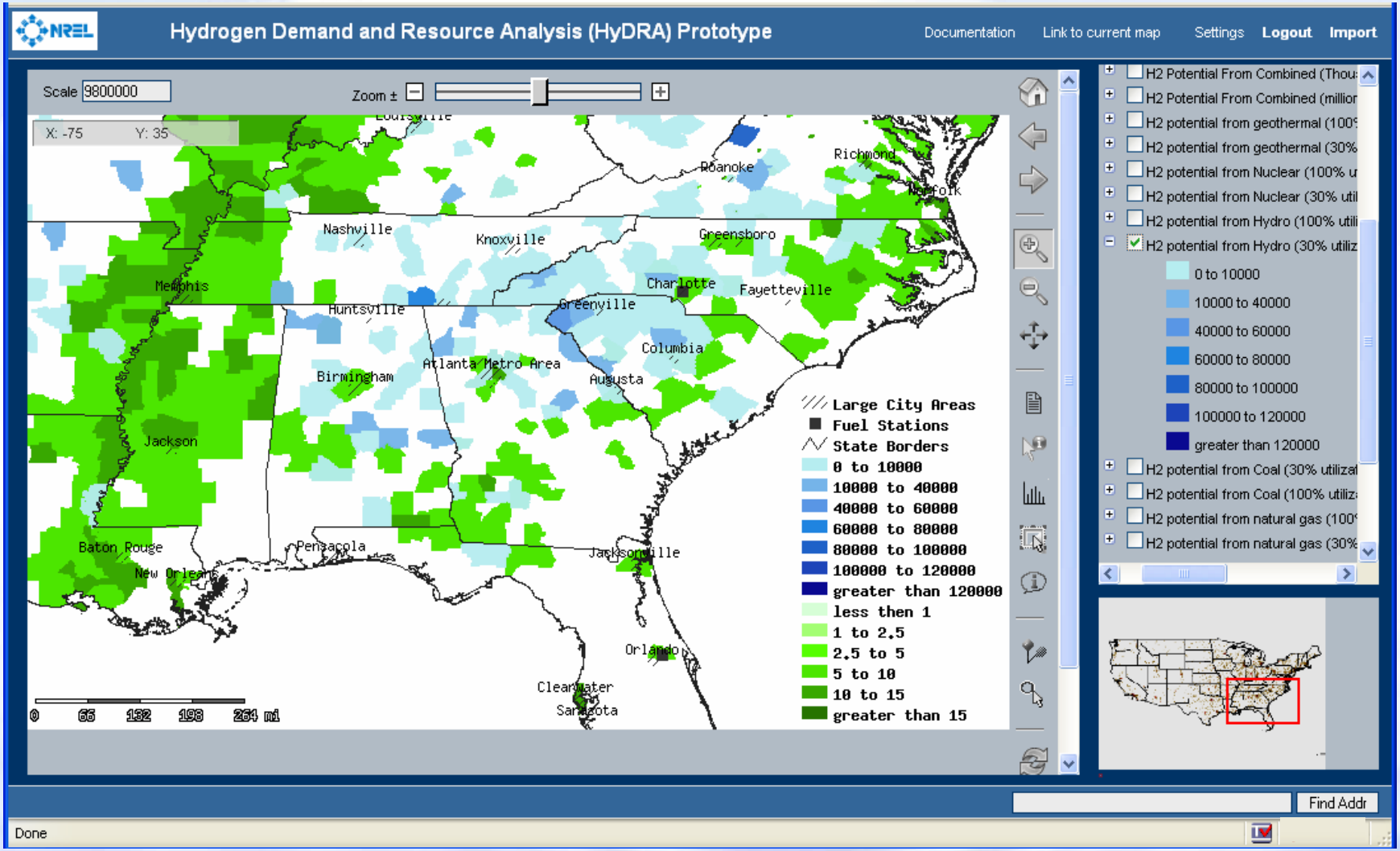
Hydrogen Production from Biomass



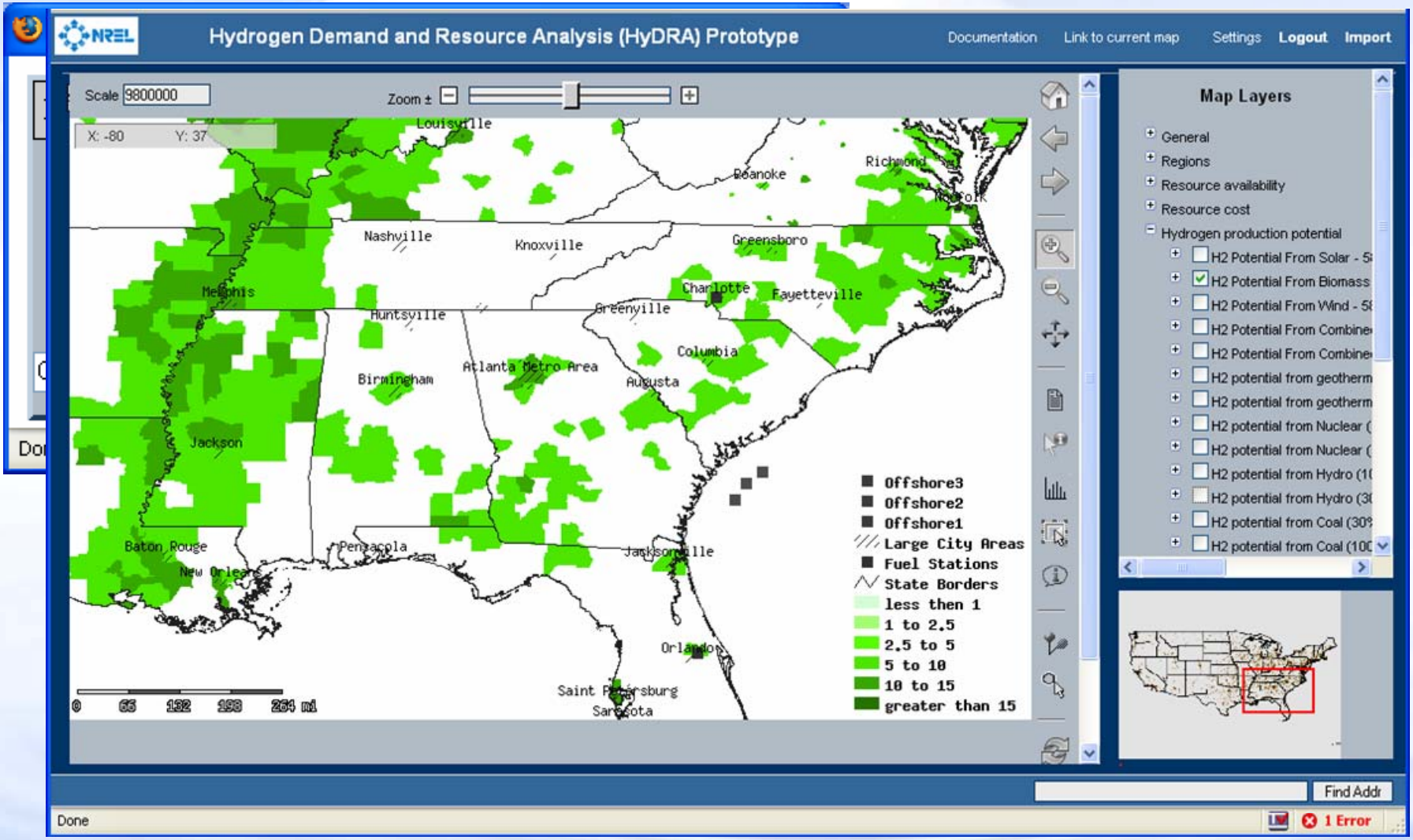
Hydrogen Production from Biomass



Hydrogen Production from Biomass, Hydroelectric



User Data Import



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 provided by DHS and restricted to Federal employees*

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
- **Builds on existing work at NREL**
  - →GIS resource analysis
  - →Hydrogen demand scenario analysis
  - →Renewable Planning Model
- **To access HyDRA, visit: https://rpm.nrel.gov/rpmentry/ and request a login**

Visit the Hydrogen Analysis Resource Center (HyARC):
www.hydrogen.energy.gov/resource_center.html

Additional Slides

Future Work –
Macro System Model Integration

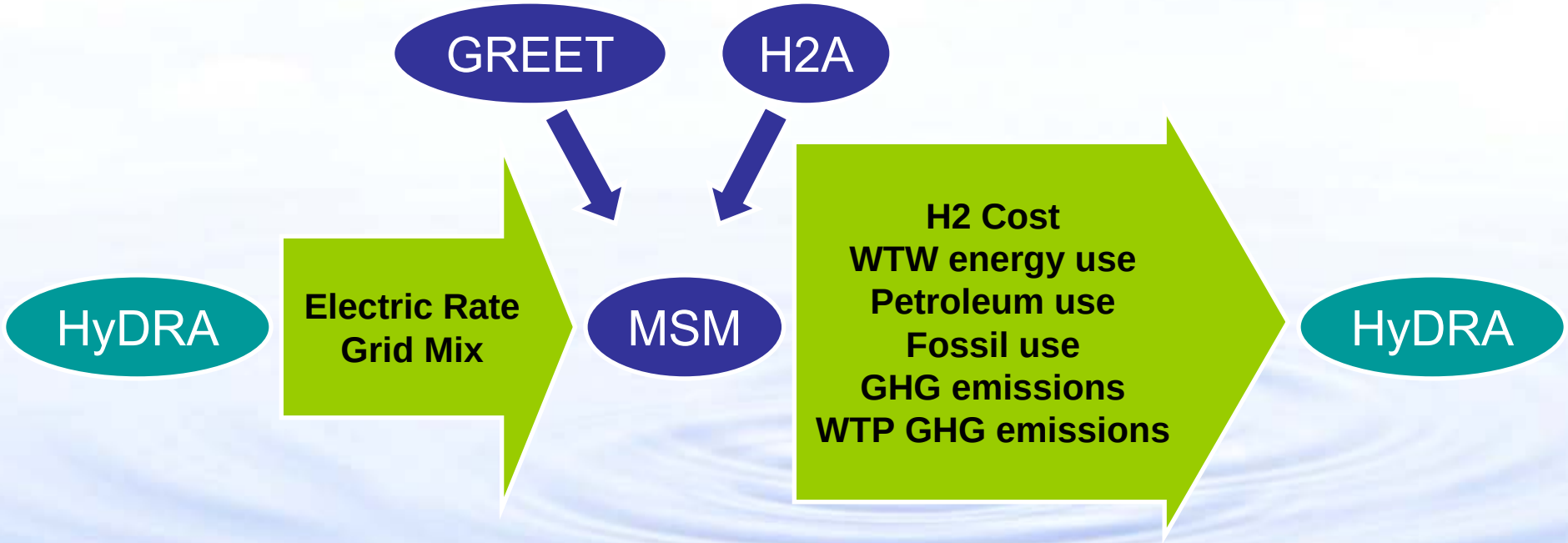
***Step 1:* Manually integrate forecourt SMR and electrolysis costs**

- County by county analysis
- Allows us to validate integration with known results

***Step 2:* Build new electricity emissions layer for HyDRA**

Future Work –
Macro System Model Integration

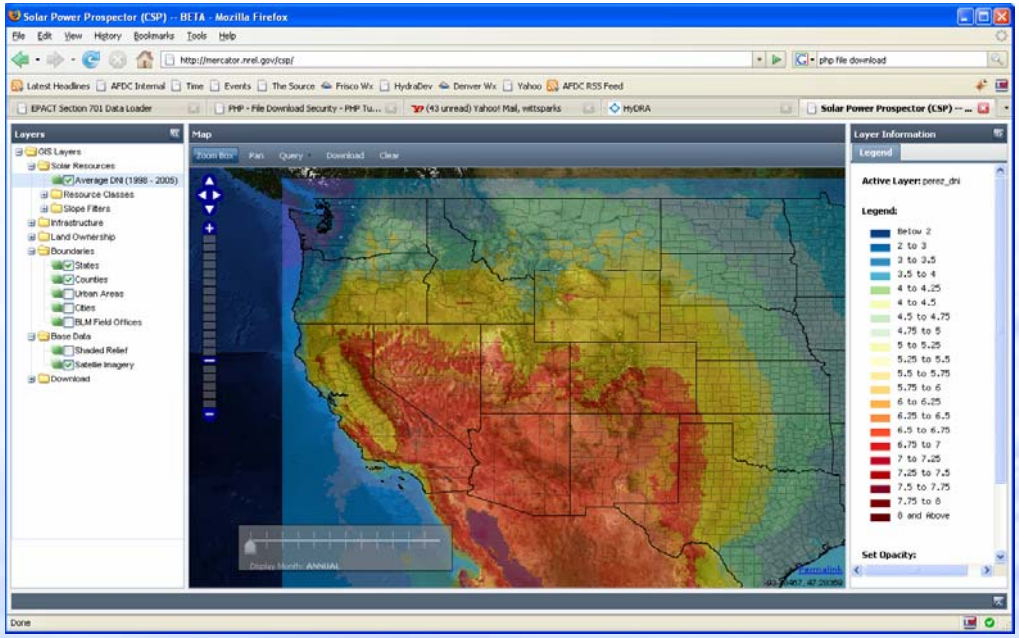
Step 3: **Programmatically integrate cost and emissions forecourt electrolysis**



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 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

Critical Assumptions and Issues

1. **HyDRA datasets and functionality will continue to increase**
   i. **Assumption:** HyDRA is already seeing the limit of usability given the number of datasets and user interactions currently available in the application.
   ii. **Solution:** The front end and back end need minor modifications to ensure maximum usefulness. Application architecture will continue to sit on a PostGRES/PostGIS database, and run php in the back end. All data layers will reside in the PostGRES database. The user interface will utilize the Javascript EXT-JS libraries and OpenLayers (to interface with MapServer.) TileCache will be used to improve performance by caching map requests.

Critical Assumptions and Issues

2. HyDRA will be integrated into the Macro System Model to provide spatial analysis capabilities

i. **Assumption:** HyDRA will provide a front end to Macro System Model spatial analysis.

ii. **Solution:** The capability of programmatically interfacing HyDRA and the Macro System Model is being designed and built this year. The capability of providing county-level data from HyDRA to MSM, and having MSM provide cost and emission county level data back to HyDRA, will be developed. In the longer term, interfaces to more complex models such as HyTRANS, NEMS, HDSAM, HyDS ME and other hydrogen optimization models in the hydrogen portfolio should be explored.

Critical Assumptions and Issues

3. **Layers of resource, demand, and infrastructure are based on the same geographic area. For HyDRA, the default aggregation level is by county, unless data are only available at a larger scale (such as state).**
   i. HyDRA at this time is focusing on the county level of aggregation and the state level of aggregation. The application can use smaller levels of aggregation, but to minimize issues of processing time the county level was chosen.
   ii. If in the future an application is interested in using more detailed data, HyDRA can accept such data.
   iii. Some data are only available at the state level. If others have more detailed data HyDRA can import those data.