NREL
NATIONAL RENEWABLE ENERGY LABORATORY

The Role of Resource Assessment in Scaling Up Renewable Energy




Charging Ahead: Scaling Up Renewable Energy in the Developing World

Nisha Thirumurthy

October 27, 2015

Overview

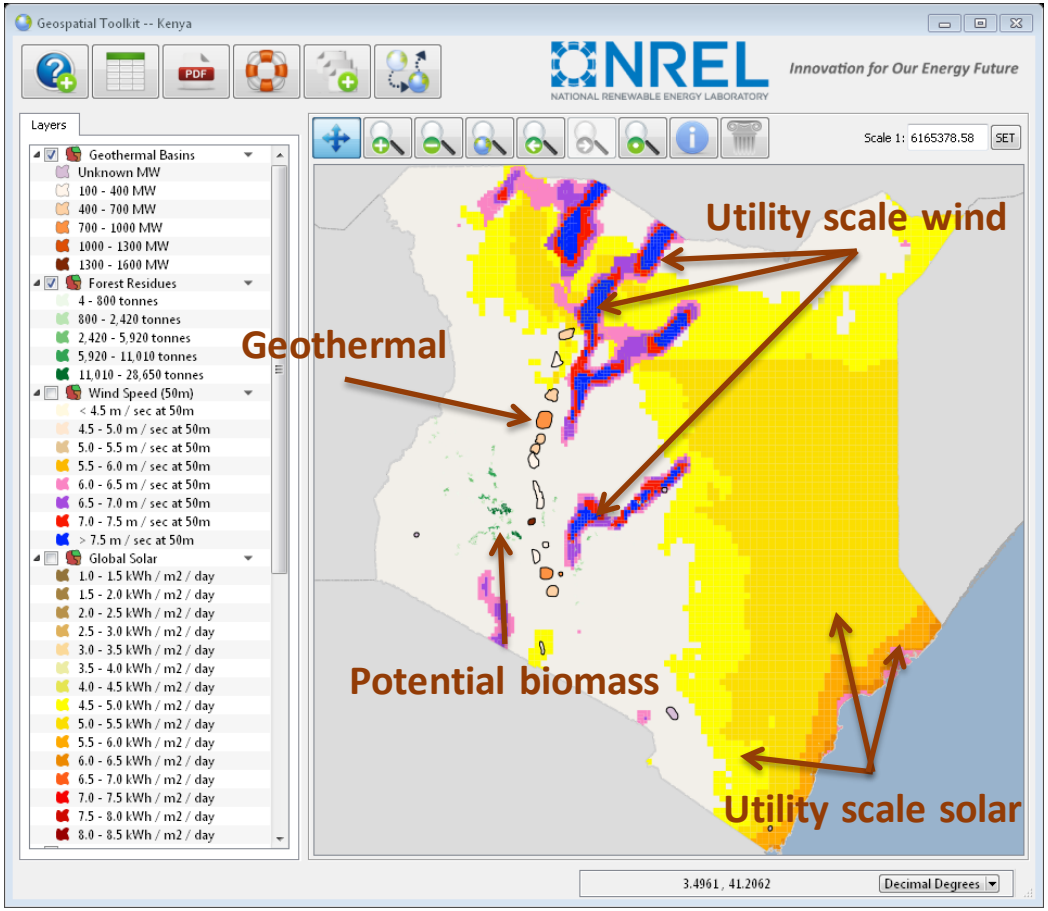
- Objectives of resource assessment
- Impacts of state-of-the-art technology and modeling capabilities on resource assessment
- Transitioning from static maps to data products
- The value of visualization and analysis
- Examples of tools

Why is resource assessment critical to scaling up renewable energy?

Renewable energy resources are characterized by their ***locational concentration***

To plan for significant deployment, RE stakeholders need to understand:

- ***Where*** **are the best resources?**
- ***How much*** **of each resource is available?**
- ***When*** **are these resources available for generation?**
- ***How*** **do different factors impact theoretical, technical, economic, and market potential?**



Who benefits from high-quality resource data?

High quality resource data underlies all critical elements of robust RE planning and deployment

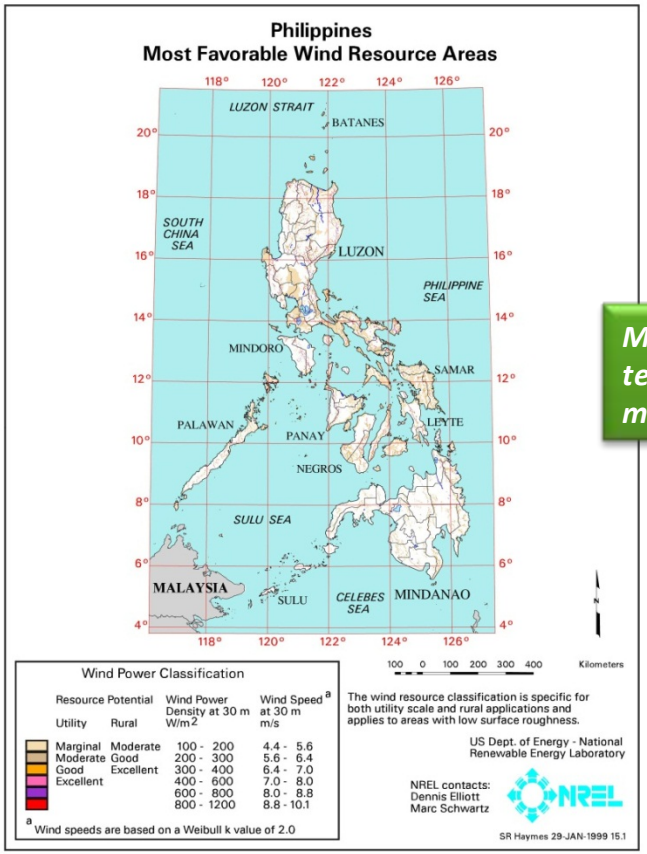
- *Policy makers* need information on the aggregate RE potential at the national and provincial levels to set generation targets, develop incentives, design competitive procurement programs, and designate RE zones
- *Power system operators* need high resolution wind and solar data that is time-synchronous with load for forecasting and grid integration studies
- *Project developers* need data on resources and their ability to be developed (e.g., proximity to infrastructure, site suitability) to efficiently site the most competitive projects
- *Investors* need site-specific measured resource data to evaluate and validate applications from project developers and reduce risk

State-of-the-art resource assessments are improving data quality

Data quality and quantity has improved substantially over the last decade as a result of improvements in technology and modeling techniques.

2001 Wind Energy Atlas

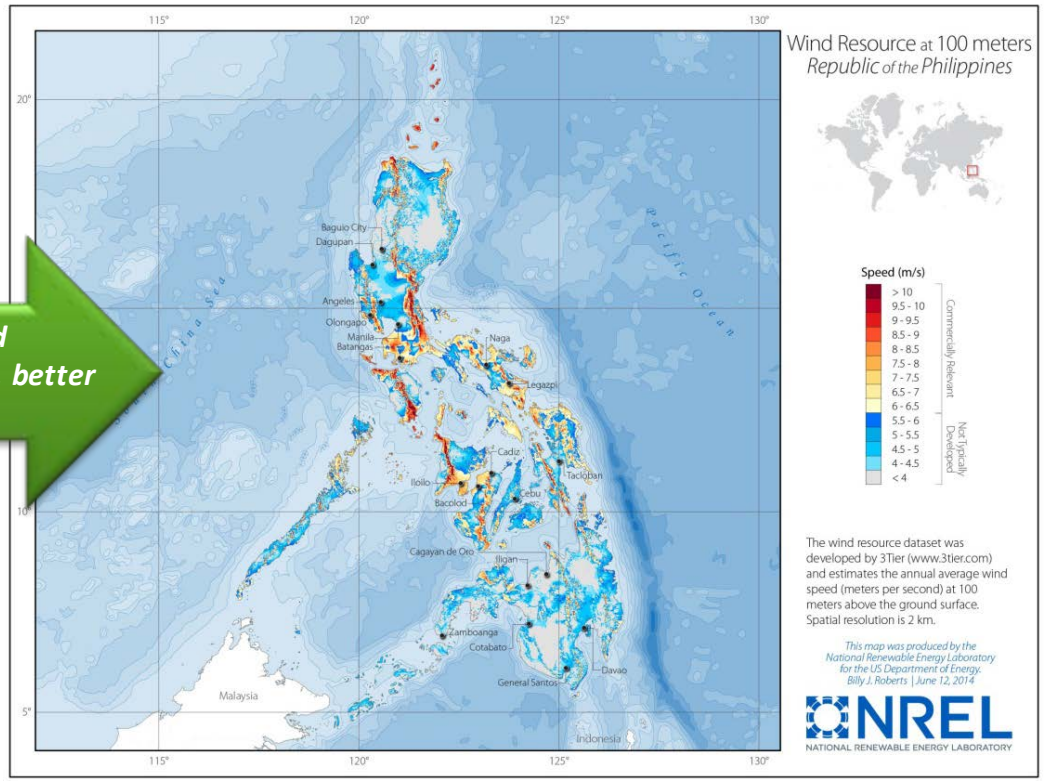
Max total potential capacity: 44.2GW



Modern wind technologies, better models

2014 Wind Energy Atlas

Max total potential capacity: 247.9GW



Includes frequency distribution, shear, wind direction, temperature, air density, and temporal information at 30, 50, 80, 100, 140, and 200m.

Moving beyond static maps to rich data products

- Resource assessments are no longer just static wind and solar maps—they are rich data products that enable planners, developers and investors can use to make decisions

- Combination of improved modeling and data storage can present large quantities of data in a variety of different ways.

Philippines 2014 Wind Data Products

Geo-referenced Wind Resource & Climatology

- At each height of 30m, 50m, 80m, 100m, 140m, and 200m:
  - Annual mean wind speed
  - Annual mean power density
  - Annual mean temperature
  - Annual mean air density
  - Annual Weibull a and k
  - Annual sectorized wind speed count (16 sectors)
  - Annual wind speed histogram (30 bins)
  - Monthly mean wind speed (for 12 months)
  - Monthly mean power density (for 12 months)
  - Monthly mean temperature (for 12 months)
  - Monthly mean air density (for 12 months)
  - Monthly Weibull a and k (for 12 months)
  - Monthly sectorized wind speed count (16 sectors)
  - Monthly wind speed histogram (30 bins)
  - Hourly mean wind speed (for hours 0 to 23)
  - Hourly mean power density (for hours 0 to 23)
  - Hourly mean temperature (for hours 0 to 23)
  - Hourly mean air density (for hours 0 to 23)
  - Hourly Weibull a and k (for hours 0 to 23)

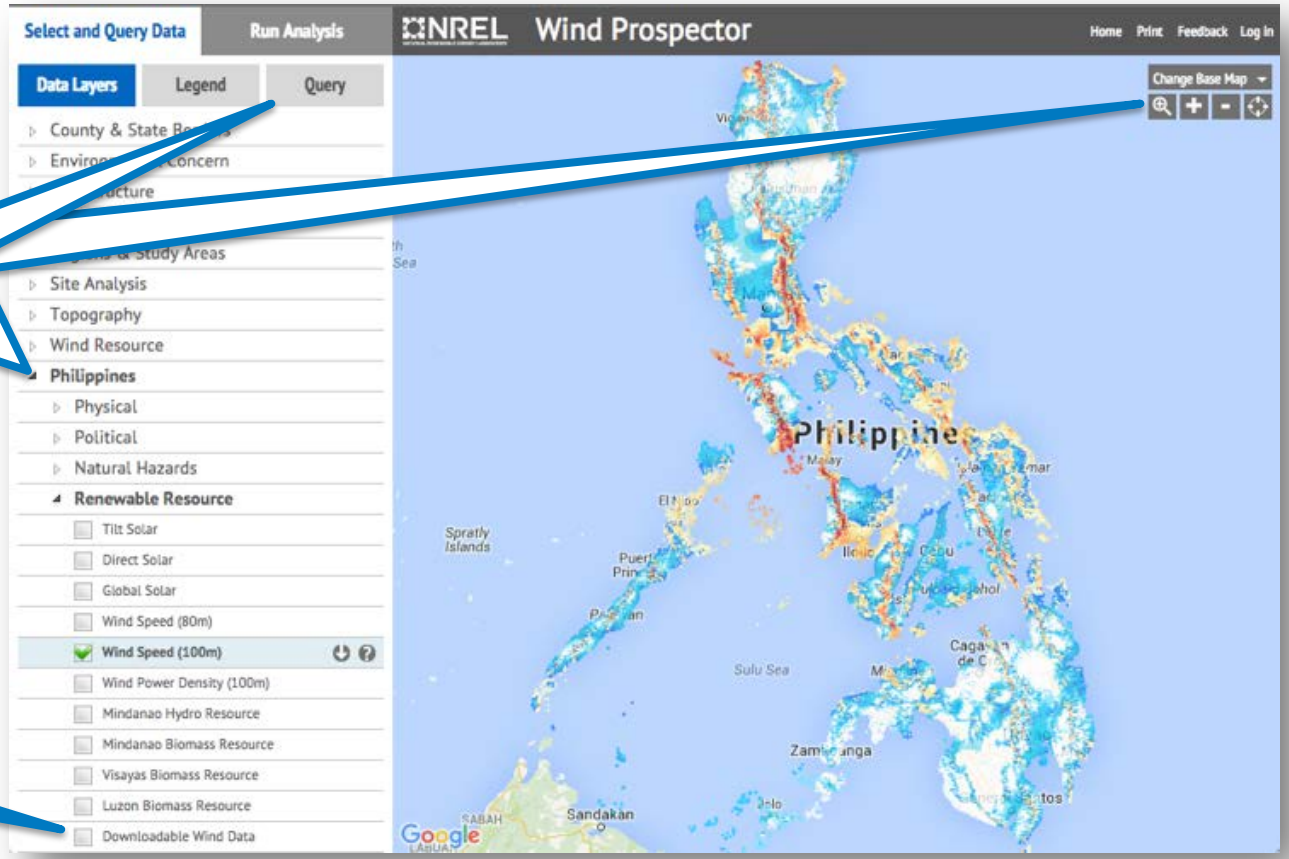
=4 terabytes of data!

Using technology to put data in the hands of decision makers

A variety of different stakeholders can now access data at granular levels to make important policy and project related decisions

Explore, query, visualize, and overlay resource, infrastructure, and environmental data needed in RE analysis

Use the tools in the interface or download the data to perform analysis locally

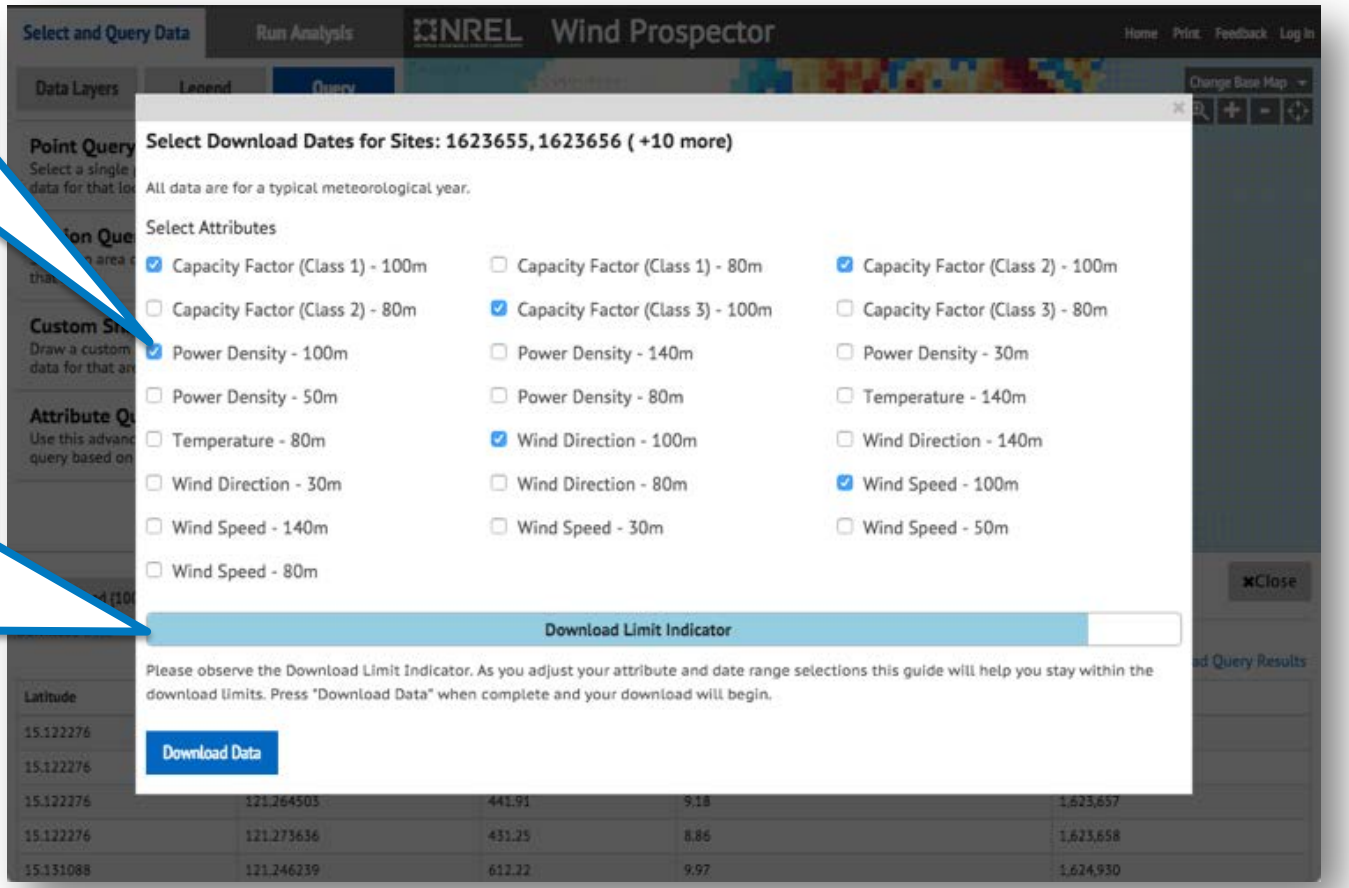


Enabling stakeholders to access the information they need

4 TB of data can be filtered in a manner that allows users to download just what they need for decision making.

Select an area of interest, and then only the attributes needed for the analysis

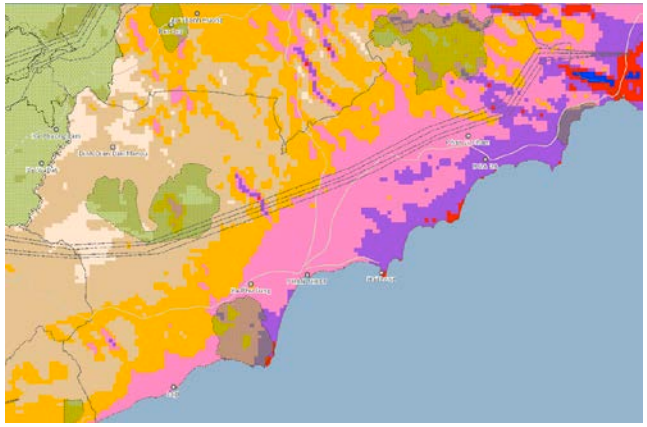
Downloading only the needed subset of the data saves download time, storage space, and processing time



The value of visualization and analysis: identifying promising areas for RE development

Effective data visualization and analysis lowers cost of exploration and project risk and allows developers to identify "low hanging" projects for development

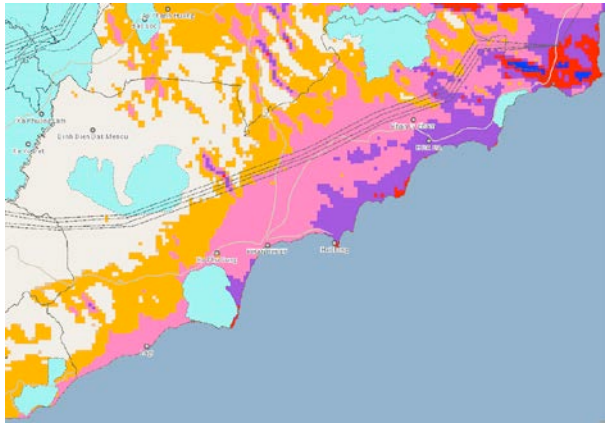
No constraints



Technical Potential

Nameplate Capacity (MW):	40,074
Total Land Area (sq km):	8,014
DC Generation (MWh/yr):	82,186,772

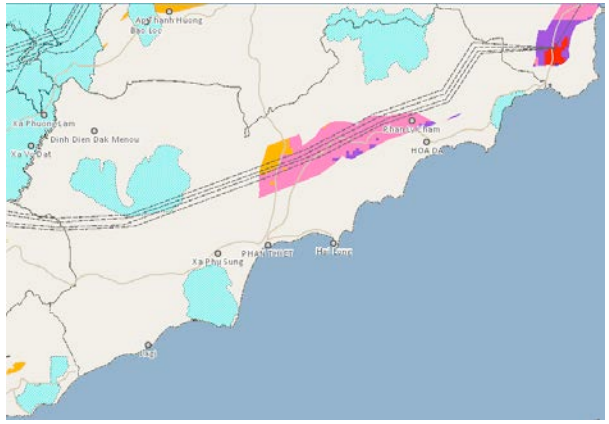
Limit to good wind resources, exclude protected areas



Technical Potential

Nameplate Capacity (MW):	23,439
Total Land Area (sq km):	4,688
DC Generation (MWh/yr):	72,902,801

Further limit to within 5km of high voltage transmission and roads



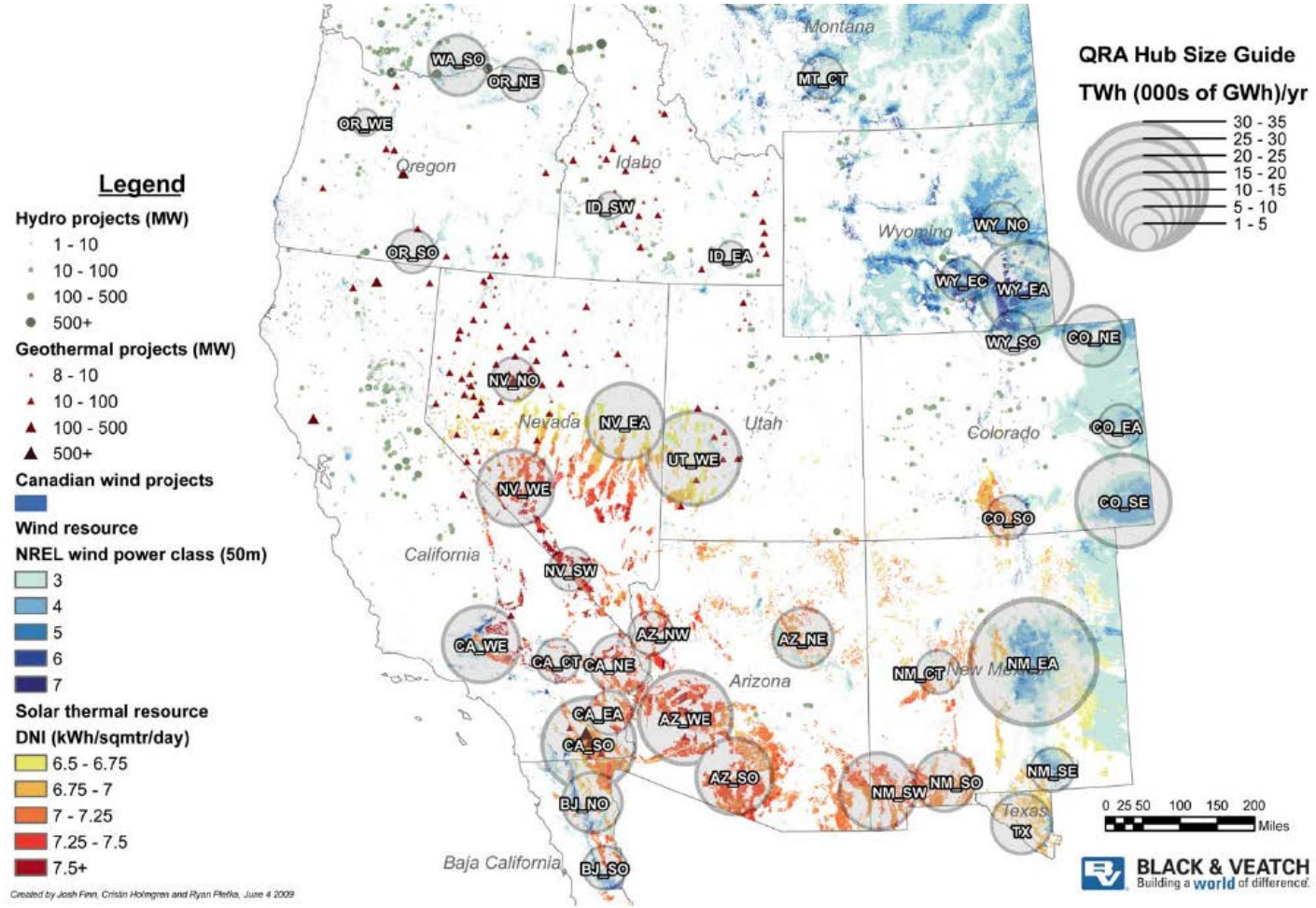
Technical Potential

Nameplate Capacity (MW):	2,673
Total Land Area (sq km):	535
DC Generation (MWh/yr):	8,375,609

Source: Geospatial Toolkit for Vietnam

The value of visualization and analysis: planning for infrastructure expansion to support RE

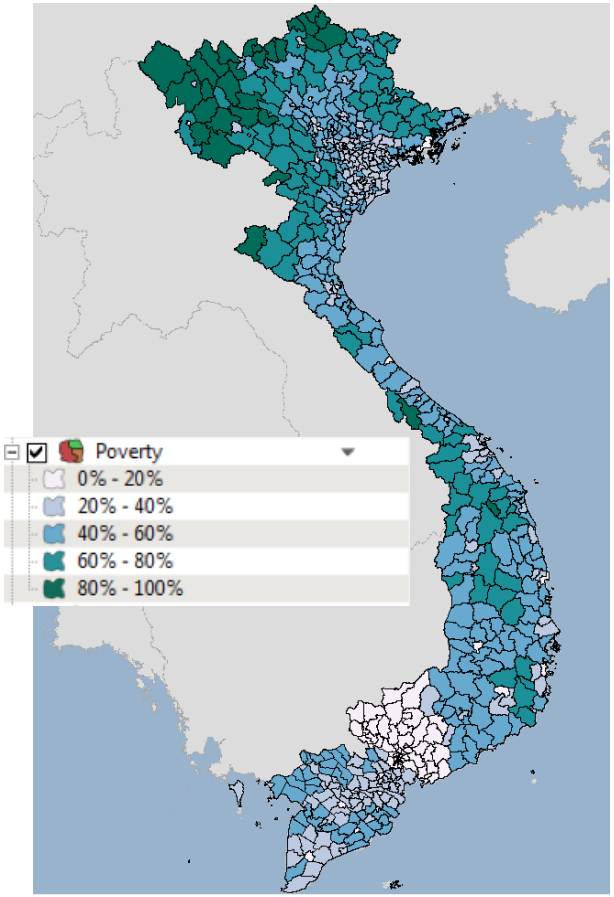
Alternatively, tools allow for the identification of good areas for renewable development and undertaking steps to make them cost effective.



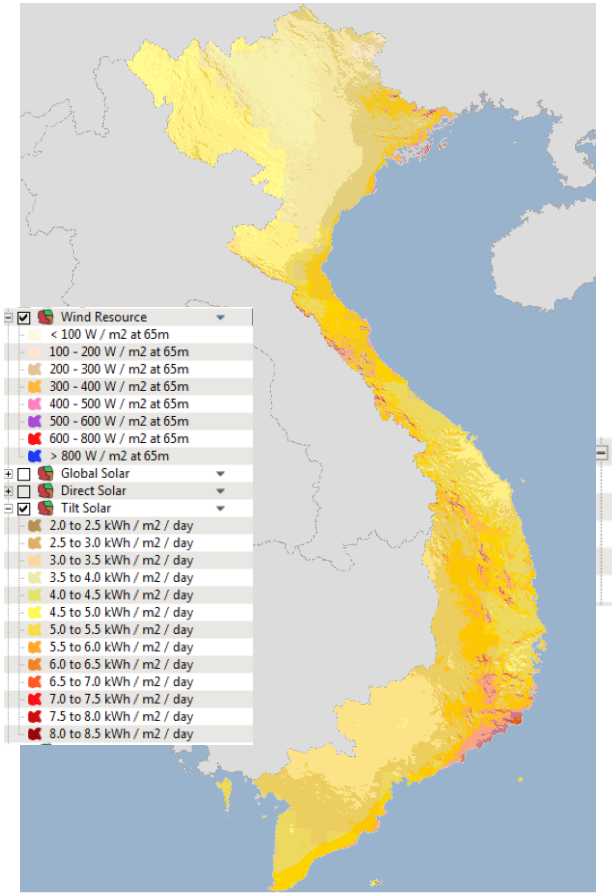
Source: Western Governor's Association and U.S. Department of Energy. 2009. Western Renewable Energy Zones Phase 1 Report. Available online at: http://www.westgov.org/wga/publicat/WREZ09.pdf.

The value of visualization and analysis: evaluating how RE supports development priorities

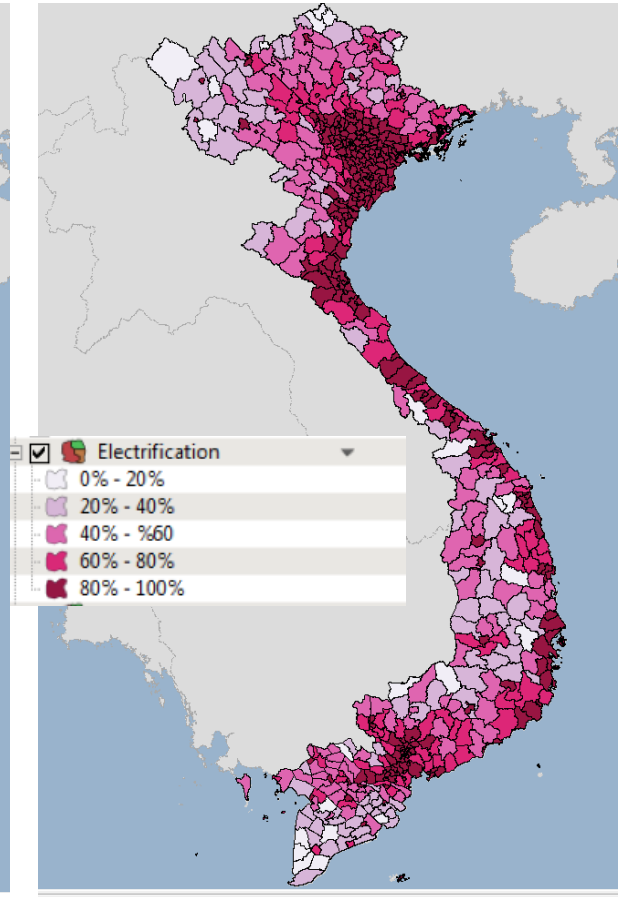
Policy makers can also determine renewable investment opportunities in areas of high poverty and/or low electrification that can help contribute to economic development.



Level of Economic development



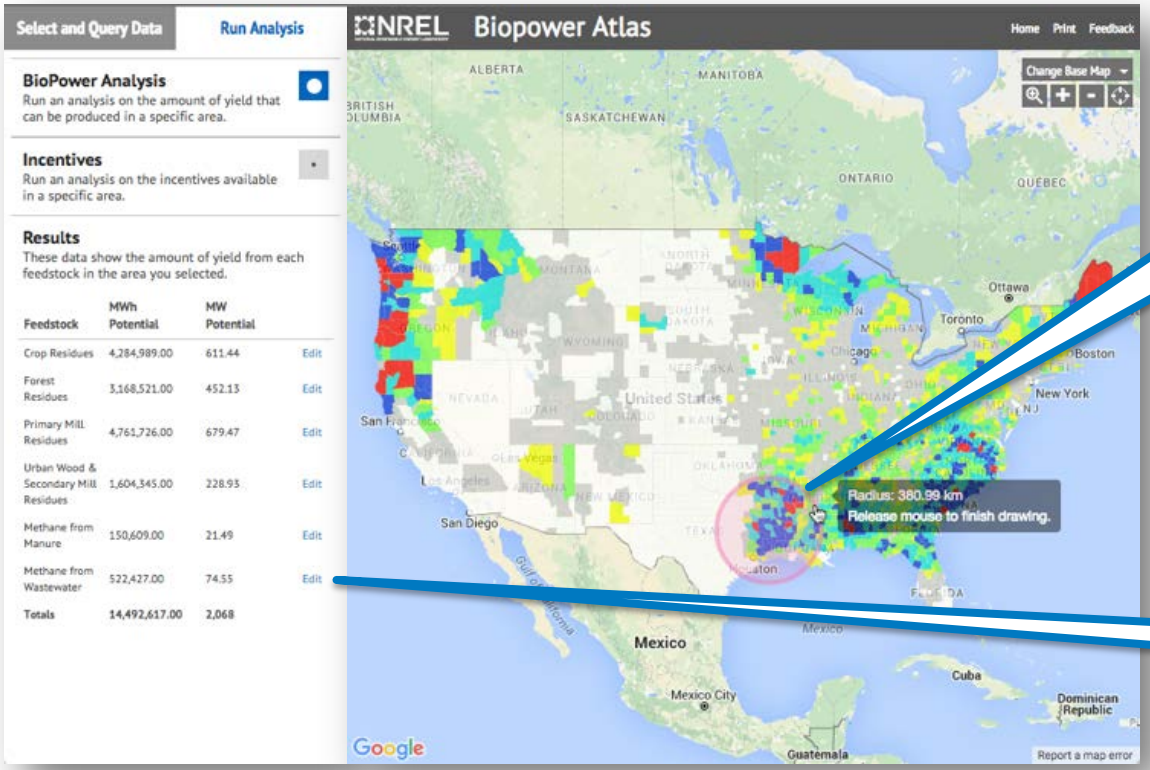
Solar and wind resource data



Improved access/rural electrification

Tools for dynamic analysis of RE: First-cut analysis to reduce prospecting risk

Tools assist the user select different areas on a map for exploration and compare the potential for RE development between different locations and users can use their own data in place of NREL data for this analysis

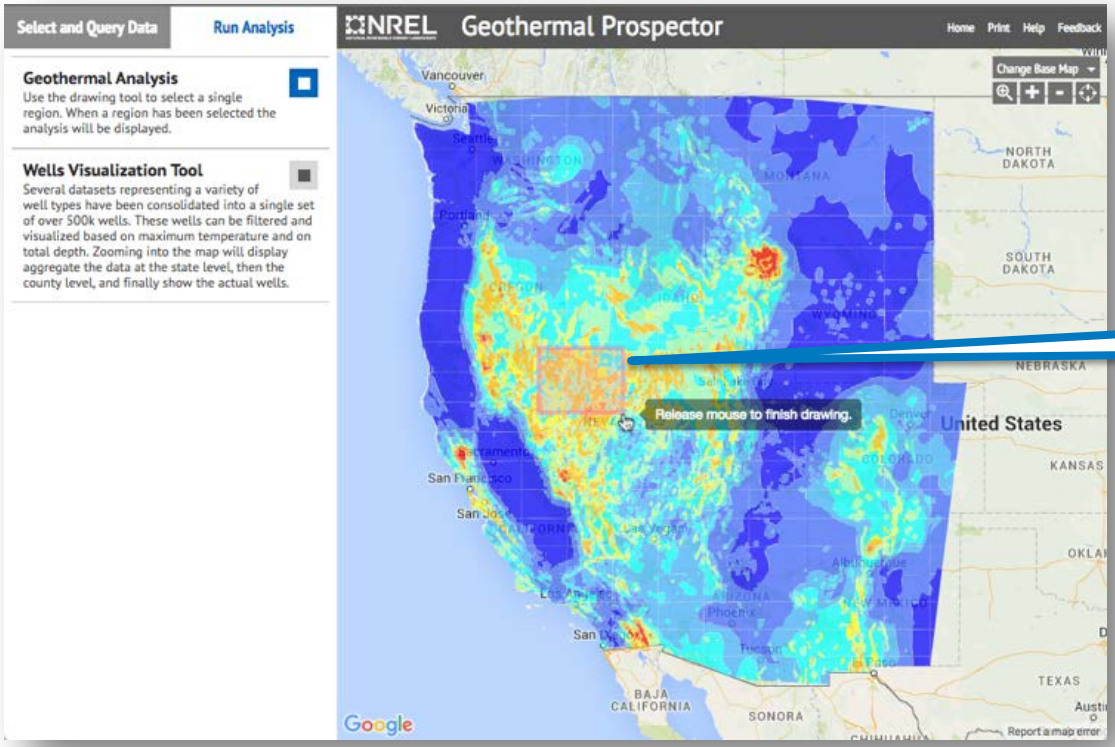


User selects an area

Summary of available biomass for selected area

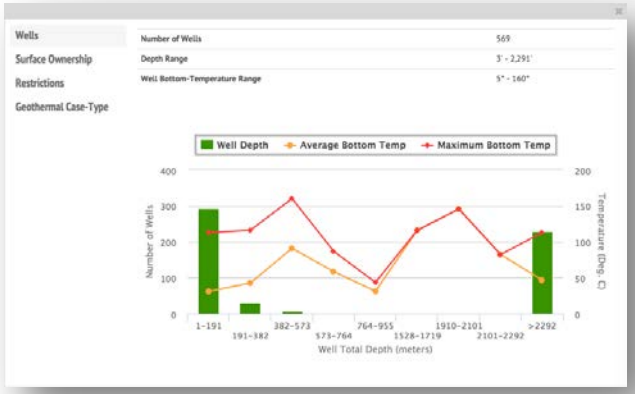
maps.nrel.gov

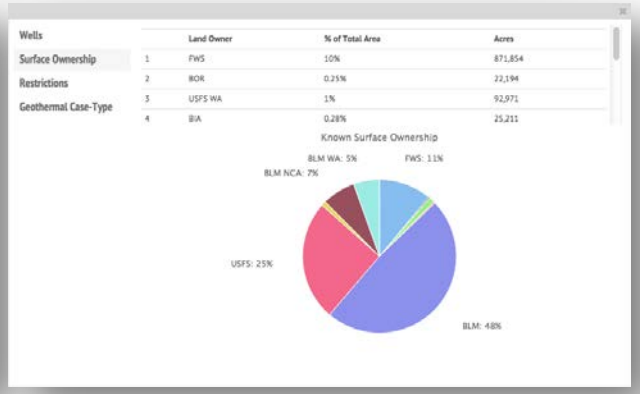
Tools for dynamic analysis of RE: First-cut analysis to reduce prospecting risk

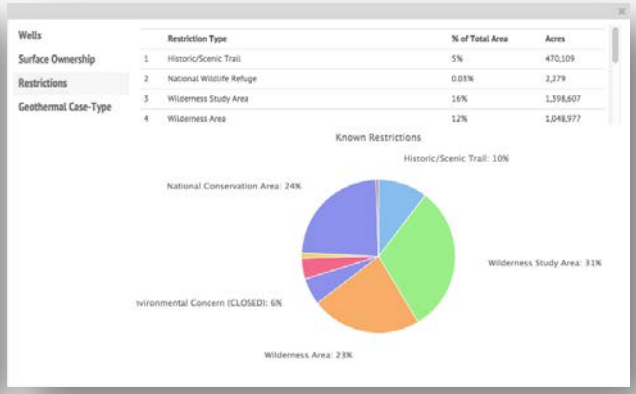


User selects an area

Summary of available wells, their temperatures, land use, and environmental restrictions are presented for selected area

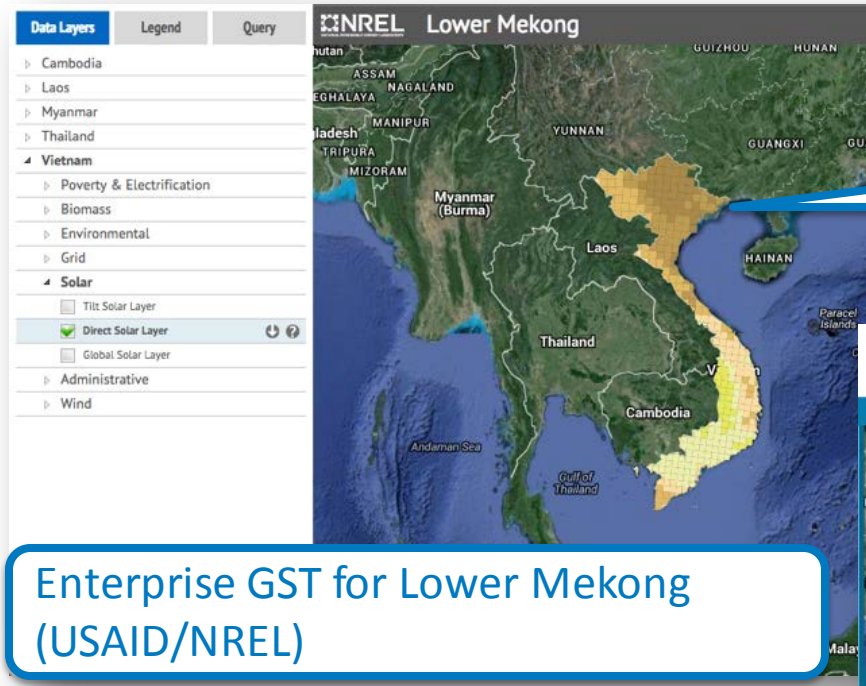






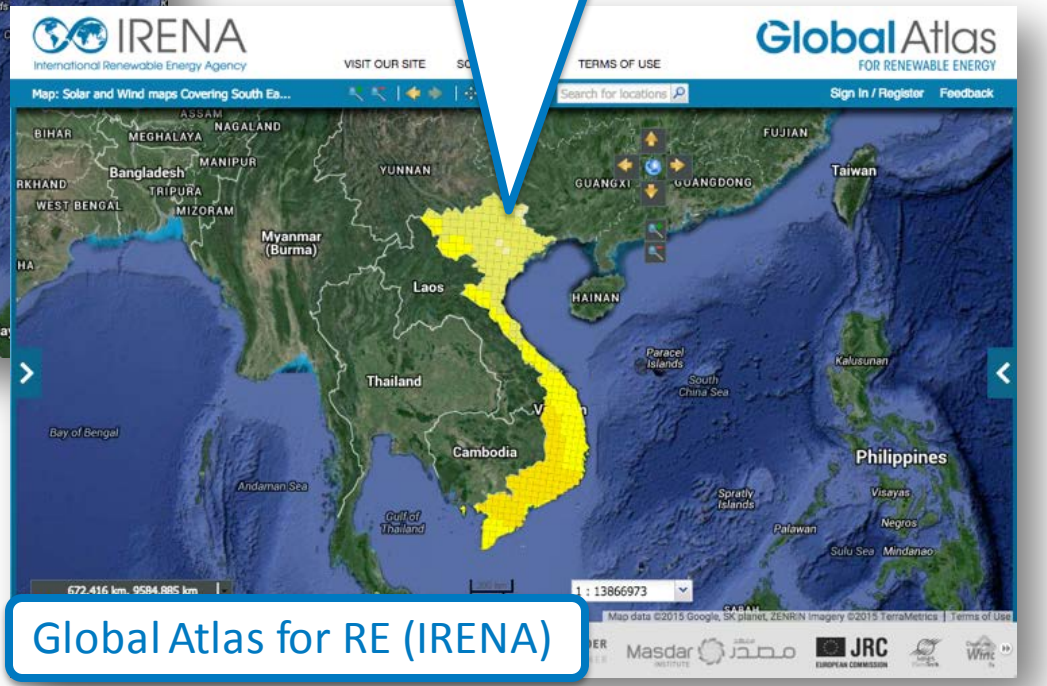
Tools for data sharing: facilitating interoperability among different platforms

Tools have the ability to be interoperable and are formatted in a manner that allows other organizations like IRENA to present it on their own platforms



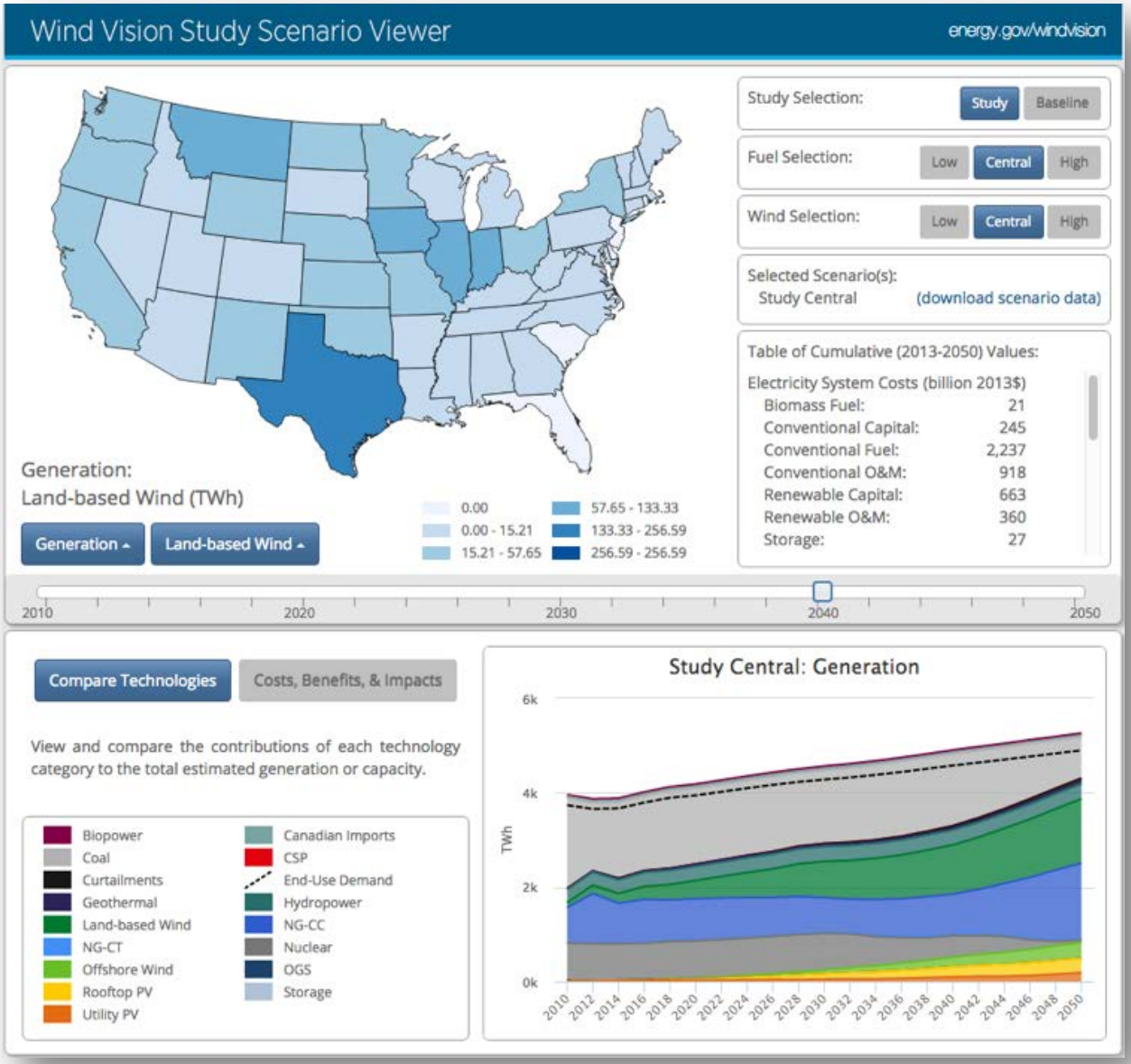
Enterprise GST for Lower Mekong (USAID/NREL)

Data from one application can be accessed from multiple applications



Global Atlas for RE (IRENA)

Tools for decision making: providing access to specific scenarios



- Users can browse 1000s of maps
- Users can see how data change over time, which is challenging to see in static charts
- Relationships become obvious as data are compared directly and over time
- When referencing the study, researchers have a visualization ready to customize and load into PPT or a paper

Takeaways

- Credible RE analysis, planning, and investment depend on high-quality data on renewable energy resource availability and other enabling factors (e.g., infrastructure and land use).
- State-of-the-art resource assessment methods are dramatically improving the quality and utility of renewable energy data.
- The outputs of renewable energy resource assessments have evolved far beyond static maps to rich and multi-faceted data products.
- Data by itself is not enough—visualization and analysis put resource data into the hands of decision-makers and are critical to planning and siting renewable energy projects.
- Many tools and programs are available to support developing countries in developing and using high-quality resource data.

Thank you!

Nisha Thirumurthy
National Renewable Energy Laboratory
Nisha.Thirumurthy@nrel.gov

Links

Web based GIS at NREL
https://maps.nrel.gov/

Geospatial Toolkits
http://www.nrel.gov/international/geospatial_toolkits.html

IRENA Global Atlas
http://irena.masdar.ac.ae

Videos outlining online analysis capabilities
Fully functional web based GIS (with large data download): https://www.youtube.com/watch?v=4_MTFQR0Ruc
Complex data within a web GIS: https://www.youtube.com/watch?v=wZyHCTsKAqE

Wind Vision Scenario Viewer
http://en.openei.org/apps/wv_viewer/