



# Renewable Energy Data Explorer

*Mapping our Energy Future*

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Context: Good data are important.

**Accurate and up-to-date renewable energy resource data** and other geographic information system (GIS) data sets can **facilitate smart decision-making**. Analysis then turns this data into useful information for decision makers. **Data-driven decisions enable** ambitious, cost-effective, and achievable outcomes for **renewable energy deployment**.

The RE Explorer can help you with data-driven decisions.

RE Explorer provides **renewable energy data, analytical tools, and technical assistance** to developers, policymakers, and decision makers in developing countries. RE Explorer **enables users to make meaningful decisions** that support low-emission development and ultimately reduce greenhouse gas emissions.

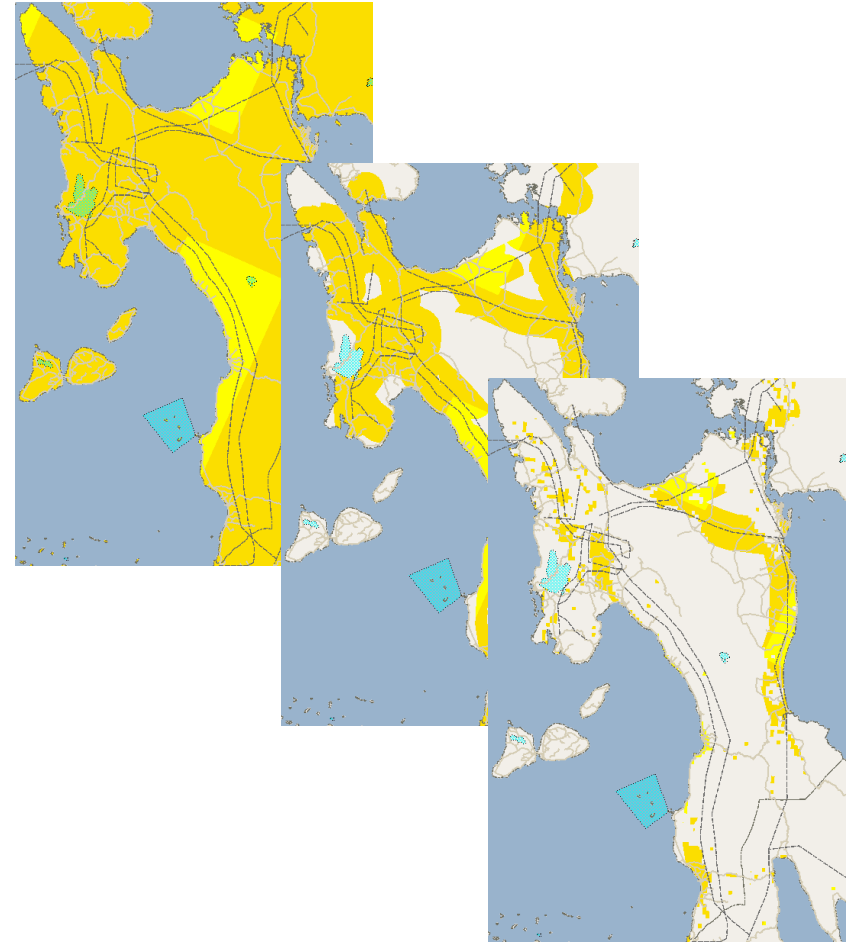
To learn more, visit [re-explorer.org](https://re-explorer.org).

The RE Data Explorer is the flagship geospatial analysis tool of RE Explorer.

The RE Data Explorer, developed by the National Renewable Energy Laboratory, is an innovative **web-based analysis tool** that uses geospatial and spatiotemporal renewable energy data to **visualize, execute, and support analysis of renewable energy potential** under various user-defined scenarios.

# Types of questions the RE Data Explorer can help answer

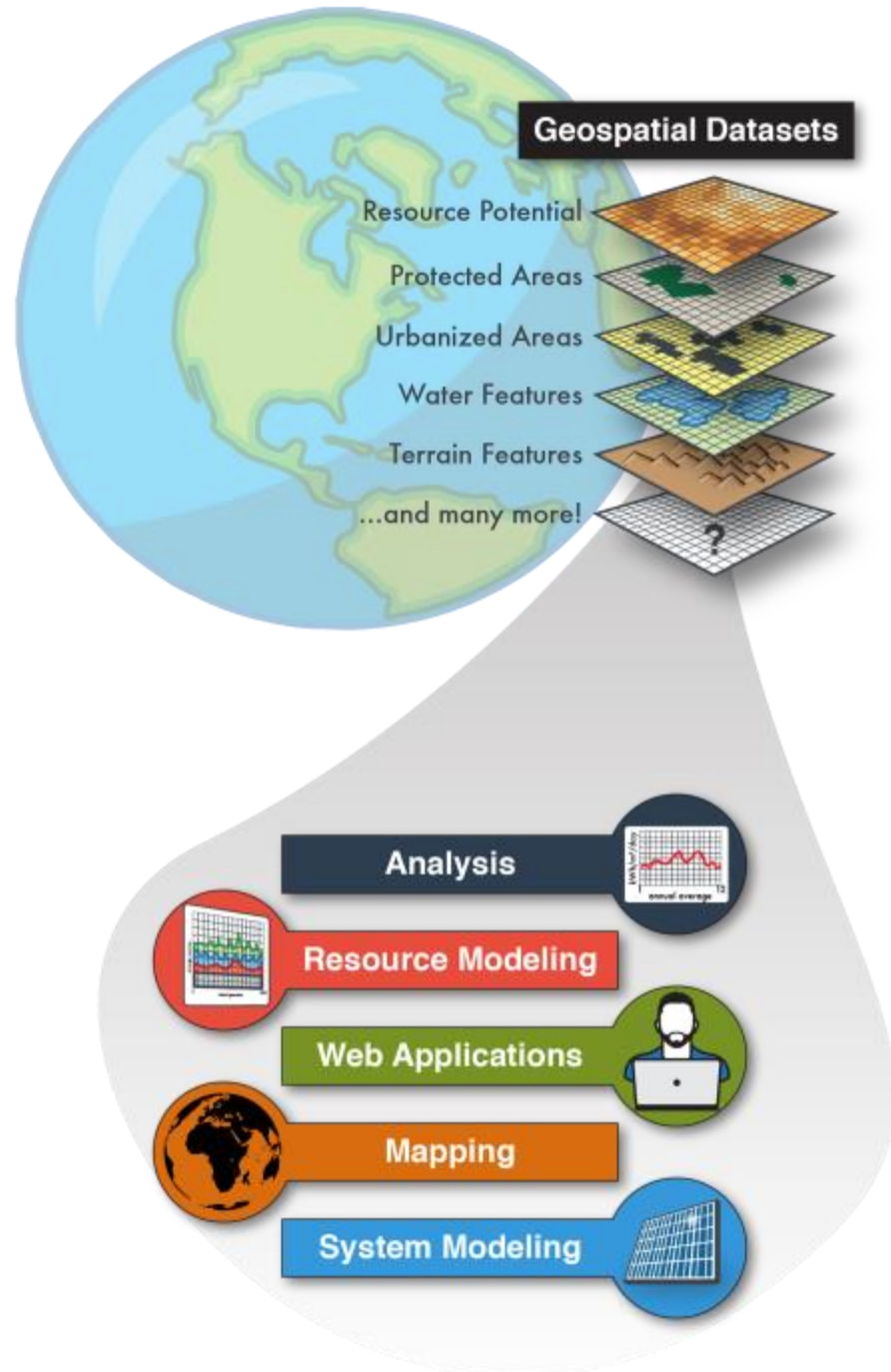
- High-level prospecting and integrated resource planning questions
- Where are the most appropriate areas to site utility-scale solar and wind facilities based on:
  - Resource quality?
  - Proximity to load centers, transmission lines, and/or roads?
  - Site suitability? (e.g., terrain, protection status, current land use?)
- How does resource potential vary at the province level?
- Which sites may offer the best possibilities for investment in long-term measurement stations?



[re-explorer.org](http://re-explorer.org)

**Geospatial analysis** provides a distinct perspective of the physical world, a unique lens through which to examine events, patterns, and processes that operate on or near the surface of our planet.

Source: *Geospatial Analysis – 5<sup>th</sup> Edition, 2015 – de Smith, Goodchild, Longley*







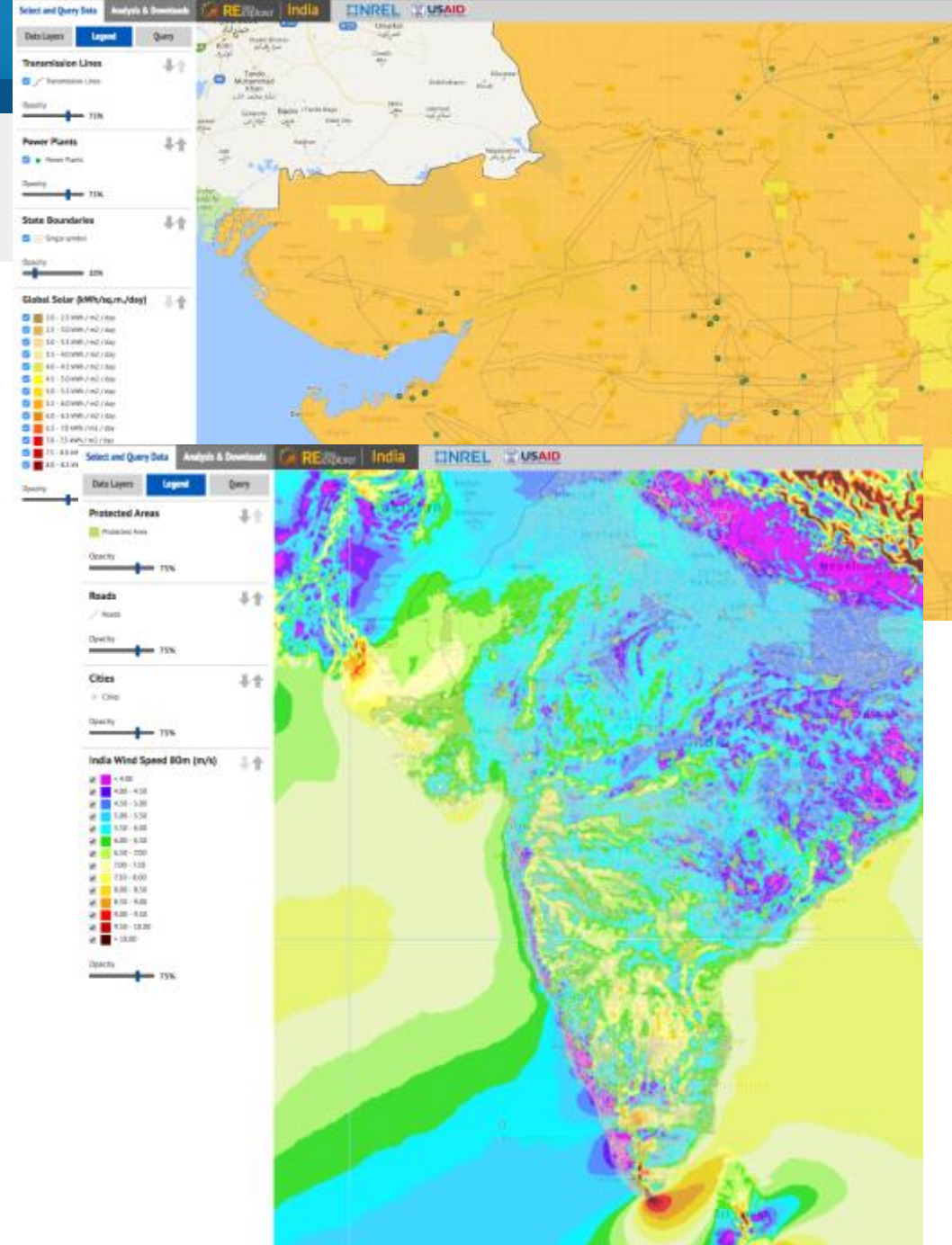
The RE Data Explorer is available for Mexico, Ghana, Kenya, Kazakhstan, Afghanistan, Pakistan, India, Nepal, Bangladesh, the Lower Mekong region, Indonesia, and the Philippines



[www.re-explorer.org](http://www.re-explorer.org)

# RED-E Data

- Renewable resource data
  - Gridded solar and wind resource data
  - Possibility to add biomass, geothermal, hydro, and conventional resources when available
- Base data
  - Elevation and slope
  - Land use/land cover
  - Protected areas
  - Political boundaries
  - Cities/towns
  - Rivers and lakes





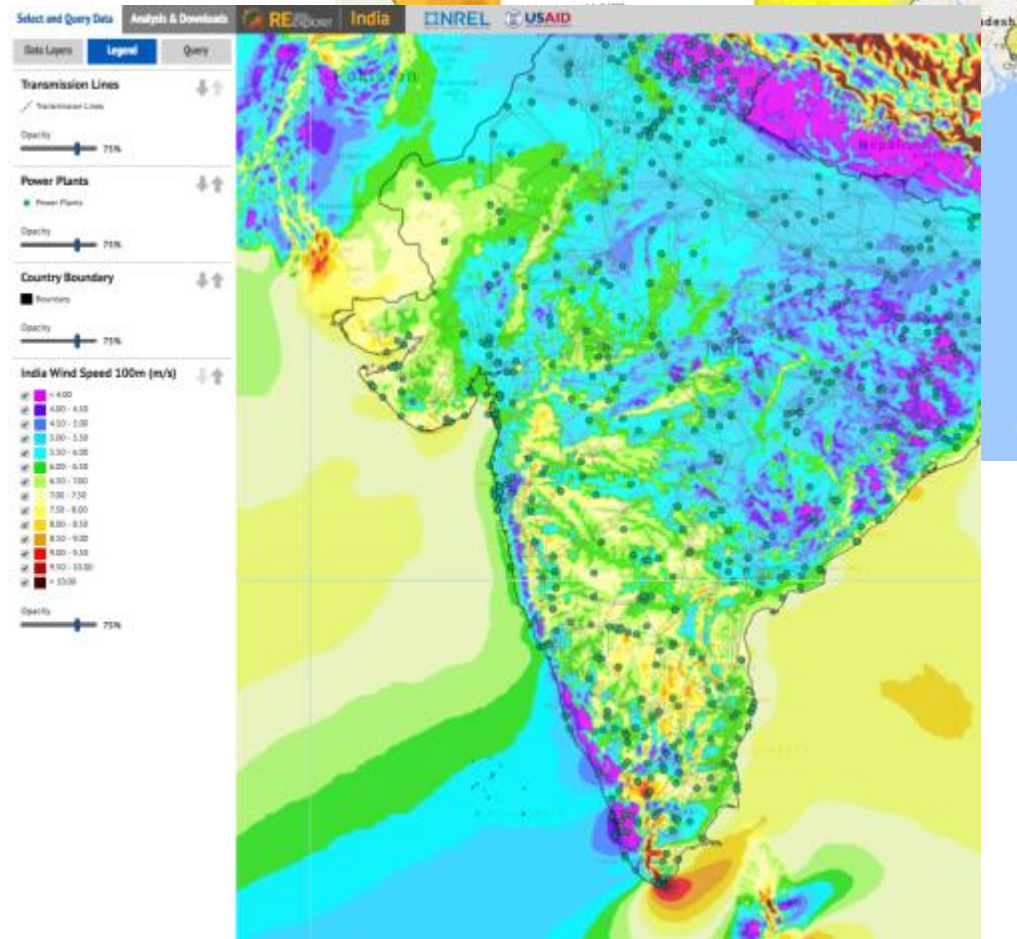
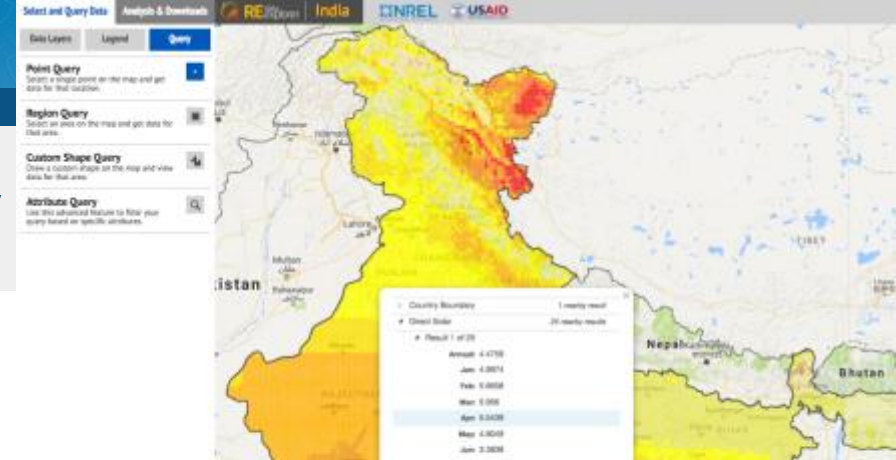


**RE**explorer  
MAPPING OUR ENERGY FUTURE

# Current Capabilities

# Core GIS Functionality

- Map navigation (zoom, pan, etc.)
- Organization and display of visual layers
- Customizable layer styling
- Point, region, & attribute queries
- Downloadable spatial data
- Layer metadata
- Printable maps, reports
- Shareable map state encoded in URL



# Core GIS Functionality

- Map navigation (zoom, pan, etc.)
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- Downloadable spatial data
- Layer metadata
- Printable maps, reports
- Shareable map state encoded in URL
- Interactive tutorials on how to use GIS functionality

The screenshot displays the REexplorer interface with several overlapping windows. At the top, a window titled "India Direct Solar Layer" is partially visible. Below it, a "Description" window provides details about the data source, mentioning "Meteosat 5 and 7 geostationary" and "Perez et al. as part of the India-US Energy Dialogue". A "Direct Solar Layer" window offers download options for "CSV", "Shapefile", "KML", and "GeoJSON". The main window, titled "Print Wizard", shows a "A Sample Printed Map" of India with a color-coded solar radiation overlay. To the right of the map is a "Map Legends" section with a color key for the "Direct Solar Layer" ranging from 1.5 - 2.0 kWh / m2 / day (dark brown) to 8.0 - 8.5 kWh / m2 / day (dark red). Below the map is a "Metadata & Footers" section with a note: "Note: Use HTML to style the footer text." At the bottom right, there are "Print" and "Download" buttons.

**India Direct Solar Layer**

**Description:** This data resource for surface collection both latitude and longitude km in size. The solar radiation represent the resource energy systems. The data the semi-empirical satellite by Perez et al. as part of the India-US Energy Dialogue. The model uses data from Meteosat 5 and 7 geostationary

**Direct Solar Layer**

Download map layer data in the following geospatial data formats:

CSV Shapefile KML GeoJSON

**Print Wizard**

**A Sample Printed Map**

**Map Legends**

**Direct Solar Layer**

- 1.5 - 2.0 kWh / m2 / day
- 2.0 - 2.5 kWh / m2 / day
- 2.5 - 3.0 kWh / m2 / day
- 3.0 - 3.5 kWh / m2 / day
- 3.5 - 4.0 kWh / m2 / day
- 4.0 - 4.5 kWh / m2 / day
- 4.5 - 5.0 kWh / m2 / day
- 5.0 - 5.5 kWh / m2 / day
- 5.5 - 6.0 kWh / m2 / day
- 6.0 - 6.5 kWh / m2 / day
- 6.5 - 7.0 kWh / m2 / day
- 7.0 - 7.5 kWh / m2 / day
- 7.5 - 8.0 kWh / m2 / day
- 8.0 - 8.5 kWh / m2 / day

**Metadata & Footers**

Note: Use HTML to style the footer text.

Print Download



# Data Downloads

- Allows users to download a pixel or region of hourly solar or 5-minute wind\* resource including ancillary meteorological data
- Provides access to 10's of terabytes of wind\* and solar resource data

\*Wind data where available

**Data Download Wizard**

SUNY

**Select Years** Select All Clear All

2000  2001  2002  2003  2004  2005  
 2006  2007  2008  2009  2010  2011  
 2012  2013  2014  TMY

**Select Attributes** Select All Clear All

Pressure  DHI  Wind Speed  
 Snow Depth  Relative Humidity  DNI  
 Dew Point  Temperature  Clearsky GHI  
 Clearsky DHI  Solar Zenith Angle  Precipitable Water  
 Clearsky DHI  Wind Direction  GHI  
 Fill Flag

**Select Download Options** Select All Clear All

Include Leap Day  Convert UTC to Local Time

Download Limit Indicator

Edit User Info Download Data

Source	Location ID	City	State	Year	Month	Day	Hour												
30	650.322693			0	2.04883957	0.17332782	26.5681016	0	-29	-13.9056									
30	650.254883			0	2.12705663	0.17344738	26.9680575	0	-28	-13.34748									
30	653.227234			0	3.25490546	0.17333739	68.6932295	0	-17	-13.347843									
30	653.151345			0	3.44026637	0.17333569	69.8351667	0	-17	-13.397724									
30	653.800476			2	3.53569674	0.17333739	64.2691931	0	-17	-11.718269									
30	654.196716			55	3.32729816	0.17333739	61.0796085	692	-14	-8.0048395									
30	654.621948			76	3.20210424	0.17333739	55.7836607	883	-12	-4.863261									
30	654.175842			72	3.07104802	0.17344739	53.5385185	967	-11	-3.0218406									
30	653.254028			139	2.53493979	0.17332786	50.6771644	800	-10	-1.7823087									
30	652.498718			261	2.08180237	0.17333569	49.8425822	350	-10	-1.2265075									
30	651.818359			236	2.13203335	0.17333739	53.4559337	65	-9	-1.6241779									
30	651.601624			151	2.14889002	0.17333739	62.3098055	614	-9	-2.8959556									
30	651.171692			137	1.79875851	0.17333739	74.0654592	647	-8	-4.863447									
30	651.029907			61	1.38209212	0.17333739	89.7253619	166	-8	-7.1246498									
30	650.893005			0	1.08203793	0.17333739		100	0	-8.6817327									
30	650.96106			0	1.57028687	0.17332783		100	0	-9.5355545									
30	650.8396			0	2.10201788	0.17333739		100	0	-10.094358									
30	650.909096			0	3.1725311	0.17333739		100	0	-10.8405663									
30	650.841492			0	2.8753767	0.17333739	87.879407	0	-13	-11.396528									
30	650.620483			0	1.8891921	0.17333739	77.9216814	0	-14	-11.929261									
30	650.463745			0	1.6092869	0.17333569	72.0386673	0	-16	-12.535136									
30	650.472168			0	1.47371652	0.17335291	68.7174149	0	-17	-13.248922									
30	650.336792			0	1.57266414	0.17330314	65.1779408	0	-19	-13.963853									
30	650.104736			0	1.87725079	0.17335291	59.9684216	0	-20	-14.234873									
30	649.872925			0	2.23370576	0.17335291	54.9129859	0	-21	-14.499835									
30	649.893005			0	2.45936012	0.17335291	50.2454498	0	-22	-14.759957									
30	650.120483			0	2.49620795	0.17335291	46.3972983	0	-23	-14.978314									
30	650.501465			0	2.42864533	0.17335291	43.3361619	0	-24	-15.176218									
30	650.887695			2	2.37807608	0.17335291	43.1205453	0	-23	-13.402553									
30	651.357239			67	2.21911073	0.17335291	42.6567439	440	-19	-9.1668476									
30	651.757202			145	1.58231282	0.17330314	37.950542	329	-17	-7.813628									
30	651.823486			127	1.28243721	0.17335291	36.2223464	790	-16	-3.2268442									
30	651.222107			135	1.70813286	0.17335291	37.7386663	707	-14	-2.8991123									
30	650.548584			199	1.97829866	0.17331097	43.1382197	601	-13	-2.3758289									
30	650.213745			217	1.96569121	0.17331097	50.4436584	31	-11	-2.9186875									
30	649.984985			206	1.7535851	0.17331097	58.8572874	130	-11	-1.1735184									
30	649.931946			131	1.39714992	0.17331097	67.6660938	648	-10	-5.7004977									
30	650.514714			34	1.09470081	0.17331097	78.8251882	598	-10	-7.7519252									
30	650.253113			0	0.85108346	0.17331097	85.9448038	0	-11	-10.019253									
30	650.534912			0	1.74070203	0.17331097	66.5564586	0	-12	-10.680936									
30	650.795776			0	2.39259481	0.17331097	74.392753	0	-14	-11.291757									



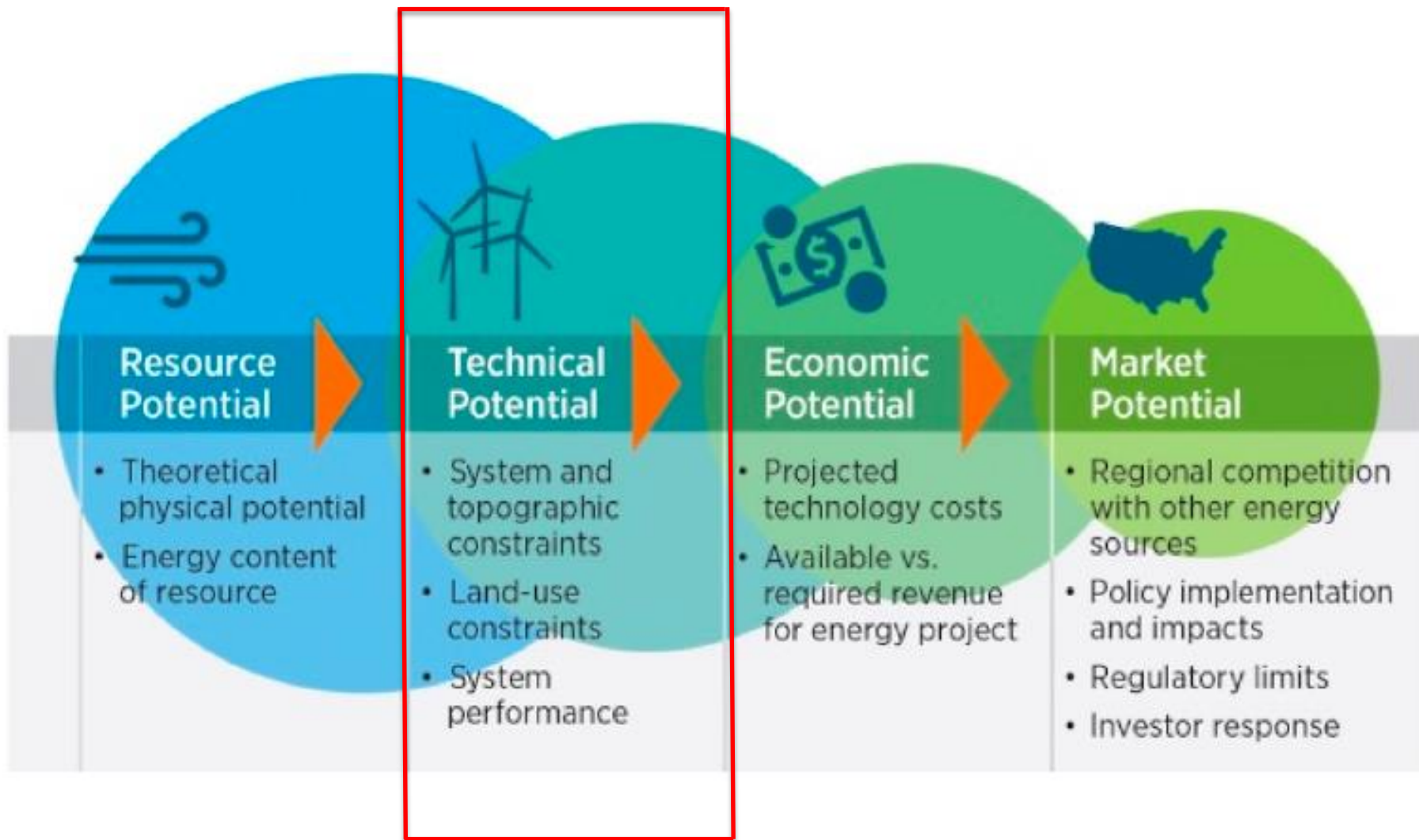
# Data Downloads

## Users

- Electric utility consultants
- Utility planners
- Academics
- Project Developers
- Energy Analysts
- Technology Engineers

## Use Cases

- Site based generator energy estimates
- Generator exceedance probabilities
- Generator financial modeling
- Base data for grid integration analysis
  - Production cost models
  - Capacity expansion models



# Technical Potential

- Dynamically conduct user-specified technical potential at the regional or country level
- Allows stakeholders to evaluate impacts of various barriers to renewable energy deployment under different conditions
- Uses powerful parallel processing to quickly conduct complex spatial analysis
- Allows users to generate multiple tabular results and spatial layers for comparison
- Interactive help and default values guide new users

## Technical Potential Tool

Run Analysis Results

Layer: India CSP 31-4-2017 16:27:47

### Cumulative Results

AC Generation: 128 million MWh/yr  
Total Land Area: 161,457 km<sup>2</sup>  
Nameplate Capacity: 5 million MW

### Land Area by Resource Class

4- 4.5 kWh/m<sup>2</sup>/day: 1,199 km<sup>2</sup>  
4.5- 5 kWh/m<sup>2</sup>/day: 158,656 km<sup>2</sup>  
5- 5.5 kWh/m<sup>2</sup>/day: 1,602 km<sup>2</sup>

### Regional/State Results

#### Gujarat

AC Generation: 128 million MWh/yr  
Total Land Area: 161,457 km<sup>2</sup>  
Nameplate Capacity: 5 million MW

#### Land Area by Resource Class

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4.5- 5 kWh/m<sup>2</sup>/day: 158,656 km<sup>2</sup>  
5- 5.5 kWh/m<sup>2</sup>/day: 1,602 km<sup>2</sup>



## Technical Potential Tool

Run Analysis Results

Technology:

1 Axis Tracking PV System

Country:

India

Region:

- Uttar  
 Goa  
 Gujarat  
 Haryana  
 Himachal Pradesh  
 Jammu & Kashmir  
 Jharkhand

Limit By Solar Resource

(kWh/m<sup>2</sup>/day):

Min: 2 Max: 9

Power Density (MW/km<sup>2</sup>):

31

Limit By Distance To

Roads:

None kilometers

Limit By Distance To Trans-

mission:

None kilometers

Exclude Protected Areas

Exclude Land Use Types:

- Barren or Sparsely Vegetated  
 Cropland/Grassland Mosaic  
 Cropland/Woodland Mosaic  
 Deciduous Broadleaf Forest  
 Dryland Cropland and Pasture  
 Evergreen Broadleaf Forest  
 Evergreen Needleleaf Forest  
 Grassland

Limit By Slope (%):

Min: Max:

Save Layer As:

Reset

Run Analysis

# Technical Potential

## Users

- Transmission developers
- Regional organizations
- NGO's
- Project developers
- State offices
- Energy Analysts

## Use Cases

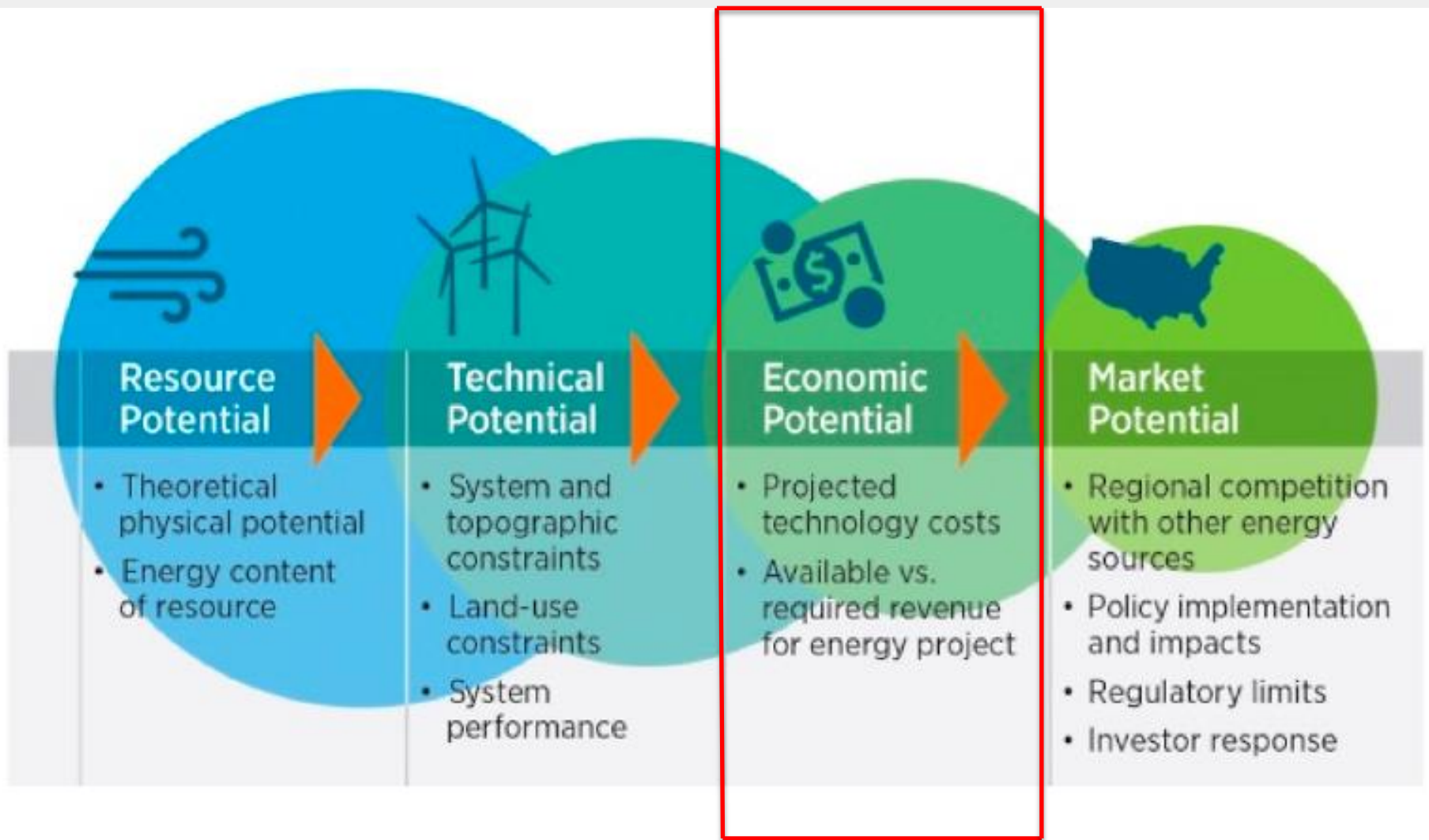
- Policy analysis – evaluation of barriers and impacts to RE targets
- Base data for grid integration analysis
  - Production cost models
  - Capacity expansion models
- Land use and environmental impact analysis
- Utility-scale site identification





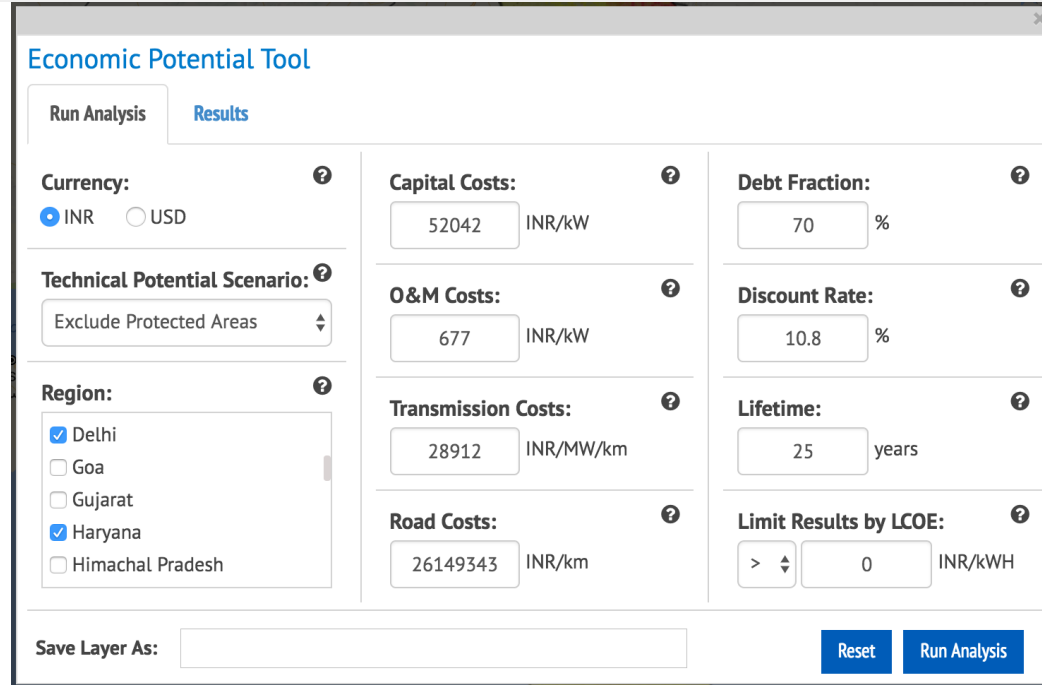
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# Upcoming Capabilities



# Economic Potential

- Assess the economic viability of different renewable energy technologies at a high geospatial resolution
- Specify scenarios to analyze the impact of incentive schemes or barriers to renewable energy deployment
- Aggregate results by national, state, or sub-state level



**Economic Potential Tool**

Run Analysis Results

**Currency:**  INR  USD

**Technical Potential Scenario:** Exclude Protected Areas

**Region:**  Delhi  Goa  Gujarat  Haryana  Himachal Pradesh

**Capital Costs:** 52042 INR/kW

**O&M Costs:** 677 INR/kW

**Transmission Costs:** 28912 INR/MW/km

**Road Costs:** 26149343 INR/km

**Debt Fraction:** 70 %

**Discount Rate:** 10.8 %

**Lifetime:** 25 years

**Limit Results by LCOE:** > 0 INR/kWH

Save Layer As:

Reset Run Analysis

# Metadata Repository

- Robust search mechanism for users to find relevant data
- Standardized format for reporting data currency, quality, resolution, etc.
- Enables RE analysis & tool development by enabling easy determination of data availability

## RE Data Explorer

Explore Data

Or, click on a map area to explore that region's data.

Contribute Data

Submit or manage your shared renewable energy data.



Sustainable Growth Working Group – Geospatial Log in Register

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**6 datasets found for "solar"** Order by: Relevance

**Global Solar**  
Global horizontal irradiance (GHI) averaged annually and monthly from April 2004 to March 2009. Data is accessible through downloading the Geospatial Toolkit Application for...

**Direct Solar**  
Global horizontal irradiance (GHI) averaged annually and monthly from April 2004 to March 2009. Data is accessible through downloading the Geospatial Toolkit Application for...

**2002-2011 India Hourly Solar Resource**  
The SUNY model produces estimates of global and direct irradiance at hourly intervals on the 10-km grid for all of India, as shown on the India solar maps. The data are...

**India Weather Files (Designed to be Used in System Advisor Model)**  
India weather files developed by NREL for use with the System Advisor Model (SAM). SAM is a performance and financial simulation model that calculates the energy output and cash...

**Annual Direct Normal and Global Horizontal Irradiance**  
The monthly and annual direct normal irradiance (DNI) and global horizontal irradiance (GHI) maps were developed from hourly data spanning January 2002 to June 2012 generated...

**Monthly Direct Normal and Global Horizontal Irradiance**  
The monthly and annual direct normal irradiance (DNI) and global horizontal irradiance (GHI) maps were developed from hourly data spanning January 2002 to June 2012 generated...

You can also access this registry using the [API](#) (see [API Docs](#)).



# Climate Change Resiliency Tool

- Allows users to view trends in temperature and precipitation under different climate change scenarios
- Adding data layers for dams and various geohazard risks (cyclone, earthquake, flood, landslide)

The screenshot displays the RE data explorer interface. The top navigation bar includes the RE data explorer logo and the text 'Lower Mekong'. Below this, there are two main tabs: 'Select and Query Data' (active) and 'Run Analysis'. Under 'Select and Query Data', there are three sub-tabs: 'Data Layers', 'Legend', and 'Query'. The 'Data Layers' tab is selected, showing a list of data layers with checkboxes and expand/collapse icons. The layers are: Cambodia, Laos, Burma, Thailand, Vietnam, Hazards (with sub-items: Cyclone Risk, Earthquake Economic Exposure, Earthquake Physical Exposure, Flood Risk, Landslide Risk), Infrastructure (with sub-item: Dams), and Climate Change Model (with sub-items: Precipitation and Temperature). The 'Climate Change Model' sub-items are checked. To the right of the list is a map of the Lower Mekong region, showing parts of Nepal, India, Bangladesh, and Sri Lanka. A tooltip is visible over the map, displaying 'Year (2010-2100): 2010' and a left arrow. A text box below the tooltip reads: 'Enter the year for the data you wish to see. Click the < to close.'

# Coming soon...

- RED-E Central Asia
- Publication: “From data to decisions: an introductory guide to link data, analysis, and renewable energy decisions”

We are always happy to explore development of other RED-E applications!

# Resources

- Ask an Expert: [www.re-explorer.org/expert.html](http://www.re-explorer.org/expert.html)
- Interactive Tutorials: [www.re-explorer.org/training.html](http://www.re-explorer.org/training.html)
- Fact Sheet: <http://www.nrel.gov/docs/fy17osti/68180.pdf>
- “From data to decisions: an introductory guide to link data, analysis, and renewable energy decisions” (coming soon)

# Acknowledgements

- United States Agency for International Development (USAID)
- World Bank (ESMAP) solar data





Thank You!

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