REexplorer
MAPPING OUR ENERGY FUTURE

RE Data Explorer

Use of the Tool to Support Renewable Energy Auctions Processes

Renewable energy auctions are now a common competitive approach to procure low-cost renewable power around the world. Ensuring a successful auction process increasingly depends on the capabilities of auction designers and participants to identify actionable and defensible insights from large data sets (on renewable energy resources and complementary data) to both attract potential investors and address stakeholder concerns. The Renewable Energy (RE) Data Explorer is a user-friendly geospatial analysis tool for analyzing renewable energy potential and informing decisions. Developed by the National Renewable Energy Laboratory (NREL) and supported by the U.S. Agency for International Development (USAID), RE Data Explorer performs visualization and analysis of renewable energy potential that can be customized for different scenarios. RE Data Explorer can support prospecting, integrated planning, policymaking, and other decision-making activities to accelerate renewable energy deployment. The broader RE Explorer website provides guidance and information to link the RE Data Explorer geospatial analysis tool to key decision areas. This document provides information on how the RE Data Explorer can be used to support renewable energy auction processes.

Renewable Energy Auction Processes and Good Practices

Renewable energy auctions provide a competitive process to procure low cost power from renewable generation. To start the auction, a government typically tenders (or requests bids) for renewable generation. Tenders can be designed to target a capacity amount (in megawatts) or an energy amount (in megawatt-hours) that will be contracted for purchase. The government or utility may choose multiple winning bids to reach the tender's target amount. Renewable energy auctions often result in lower energy costs than traditional incentives such as feed-in-tariffs —helping to ensure affordable power (Philibert 2011). The long-term contracts established under auction processes can reduce overall policy costs through procurement efficiency, competition, and more accurate reflection of electricity prices.

Photo credit: AES Lawai Solar Project, photo by Dennis Schroeder / NREL.

Auctions can also allow for participation of renewable energy in wholesale power markets, supporting optimized dispatch (Miller et al. 2013).

The following best practices support successful renewable energy auction design.[1]

- **Engaging stakeholders**—Policymakers can include several stakeholders in discussions and workshops to support auction design. These may include utilities, system operators, project developers, financiers, technical institutions, civil society institutions, and the broader public. It can be valuable to engage these stakeholders in auction design as they represent important interests across the power sector and will typically be affected by power sector investment decisions. In addition, these stakeholders have diverse knowledge that can improve decisions and help avoid issues early on in the auction process that may be unforeseen and costly down the line. At stakeholder workshops, high-level analysis and visualization of overall renewable energy technical potential for a country or jurisdiction (e.g., using RE Data Explorer) can help to kick off the workshop discussions and build support and enthusiasm for the auction process. Stakeholders can support identification of high-level objectives for the auction (e.g., expand renewable energy deployment, enable economic development, support greenhouse gas (GHG) emission reductions, and so on) and discuss the key auction design elements described below.
- **Minimizing policy costs through effective design**—Various auction design elements can be used to minimize auction process costs. For instance, a reverse auction approach often reduces costs by allowing project developers to submit bids that align with the lowest prices they would accept to develop a renewable energy project (Miller et al. 2013). Reverse auctions are one of the most common tendering approaches to support large-scale renewable energy deployment (REN21 2014); however, design of auctions is highly dependent on local and unique market conditions in specific countries and jurisdictions (Maurer et al. 2011).

[1] These practices are drawn and adapted from Cox et al. 2015.

- **Facilitating participation**—Transparent, timely, and consistent communication of accurate auction information to project developers can support successful policy outcomes and facilitate the entrance of bidders—allowing for a more competitive auction environment. Policymakers, regulators, or utilities can provide project developers with clear procurement definitions, auction rules and penalties, and guidance for submitting bids in advance of auctions. This provides developers the time to evaluate the process and improve the auction process with valuable feedback. Policymakers may also consider providing workshops or trainings on the auction process to educate stakeholders, increase participation, and support successful outcomes. These outreach activities also allow for stakeholders to learn more about the process, tools (e.g., RE Data Explorer), data sets (such as renewable energy resource data), and other elements related to the auction design and preparation of successful bids.
- **Providing a stable auction environment**—Policymakers can support greater participation of the private sector by providing a stable auction environment (i.e., reducing unexpected changes to the process and rules). Building on lessons learned over time, revisions to the auction process can be made transparently to support ongoing investor confidence. Policymakers can also design auction monitoring systems to ensure appropriate bidding behavior (Maurer et al. 2011).
- **Ensuring developer experience and technical capability**—In some cases, auctions can encourage inexperienced developers to submit bids that are too low, resulting in unsuccessful projects. Policymakers can mitigate this problem with the design of a two-phase tender process that requires bidders to demonstrate experience and technical capability before they submit a complete bid (Couture et al. 2010; Couture et al. 2015). For example, the first phase may be a Request for Qualifications, and then a subset of entrants is eligible to bid into a Request for Proposals. In addition, and as noted above, auction designers may also choose to provide trainings on technical skills and analyses to support successful bids. Such trainings may be complemented with information on key tools and open datasets (e.g., high-quality, free renewable energy resource data on RE Data Explorer) that can allow for further comparison and validation across several data sets and analyses when preparing a bid.
- **Considering land-ownership issues**—In more nascent markets where land-ownership issues may impact the auction process, the government may consider purchasing the land for projects in advance. Suitable areas can be initially identified with the aid of geospatial analysis tools, such as RE Data Explorer. The tool can overlay renewable energy resource data on considerations of land constraints, transmission and road networks, and other key concerns to identify areas with high-quality renewable energy resources that are suitable for development.

RE Data Explorer Uses and Guidance to Inform Auctions

Data Collection and Development

High-quality renewable energy resource data are critical inputs to support renewable energy auction processes from a design and project development perspective. While auction designers and developers can purchase these data, open and public dissemination of the data can benefit transparency and robustness of auction processes, ensuring a level playing field.

Within the RE Data Explorer, renewable energy resource data are freely and openly available for many countries and regions including Afghanistan, Bangladesh, Central Asia, Colombia, Dominican Republic, Ghana, Haiti, India, Kenya, Mexico, Nepal, Pakistan, Peru, and Southeast Asia. The granularity of data differs across these countries. While annual average resource data can be useful to inform auctions, hourly and sub-hourly resource data provides a more accurate picture of resource availability throughout the day in specific areas of a country. Box 1 describes annual average and time series renewable energy resource data in more detail.

Within the RE Data Explorer, solar resource time series data are available for much of North and South America along with parts of South Asia. Complete coverage of these regions/countries within the RE Data Explorer suite include, Bangladesh, Colombia, Haiti/Dominican Republic, India, Mexico, Nepal, and Peru. Partial coverage includes Afghanistan, Pakistan, and Myanmar.

Box 1. Renewable Energy Annual Average and Time Series Resource Data

Annual Average Data

- Generally large coverage area
- Relatively easy to produce based on limited data locations
- Lower fidelity than time series data
- Not suitable for detailed project planning

Time Series Data

- Often involves more detailed modeling using multi-channel measurements from geostationary satellites
- Allows ability to more accurately estimate the amount of renewable energy historically available at a specific time and location
- High temporal fidelity produces significantly increased degree of accuracy

Future coverage, which is currently under development, will span the Southeast Asia region under the USAID-NREL Advanced Energy Partnership for Asia.[2] Wind resource time series data at multiple hub heights is available for Kazakhstan, Philippines, Bangladesh, Pakistan, and India. In addition, measured wind data is available for Bangladesh. These data, available within the Data Download Tool in the RE Data Explorer, can feed into key steps of an auction process, such as site selection and preparation of bids, described below. See Box 2 to learn more about options to collect, develop and validate wind and solar data.

Stakeholder Convening to Inform Auction Design and Build Support

Government policymakers within energy ministries can convene utilities, system operators, project developers, and other civil society stakeholders to inform the design of competitive auction processes. Particularly in countries at earlier stages of renewable energy development, the RE Data Explorer can help build overall support for renewable energy development and to build awareness and understanding of upper bound technical potential for renewable energy development (described in more detail below). Users can easily visualize renewable energy resource potential and estimate technical potential, or feasible energy generation, given a set of constraints to development (or exclusions) such as protected areas, wetlands, and so on, as well as other considerations such as distance to transmission and roads and slope of land. Countries have used static maps to inform these stakeholder processes; however, RE Data Explorer is a more dynamic, hands-on tool that allows for greater engagement of stakeholders and building of greater enthusiasm around the auction process and renewable energy development more broadly.

Designing the Auction

Renewable energy auctions can be designed in various ways. In countries where renewable energy development is at an earlier stage, the Ministry of Energy, utility, or other authority designing the auction, may choose to use the RE Data Explorer to select sites for bidders to consider under the auction process. As noted above, within the RE Data Explorer, the technical potential tool enables users to identify areas with the highest technical potential in terms of capacity (MW), generation (GWh), and suitable land area (km2). To run the tool, users can select limits such as resource quality, power density, or proximity to roads and transmission. Exclusions can also be applied, which may include protected areas, land cover/land use, slope, or other culturally significant areas. Figures 1 and 2 provide visualizations of the technical potential analysis process using the RE Data Explorer.

After the technical potential analysis, auction designers can prioritize specific sites with the highest renewable energy potential for the auction process. In addition, as auction designers consider potential project sites, the visualization aspect of the RE Data Explorer can shed light on potential land-use conflicts, as well as proximity to the

[2]Drawn from the National Solar Radiation Database - https://nsrdb.nrel.gov

Box 2. How is Wind and Solar Time Series Data Collected, Developed, and Validated?

Stakeholders, including policymakers and project developers, can procure data from private companies and/or collect data from open sources such as **RE Data Explorer**. Often, project developers assemble several datasets to compare and use within various analysis tools as they assess the financial viability of projects. Key types of data and validation methods that can inform project development are described below.

Modeled data are renewable energy resource data developed with modeling methodologies. For example, atmospheric scientists use a variety of methods to estimate solar irradiance, including empirical, semi-empirical, and, more recently, physics-based methods. For wind resource data, atmospheric scientists use numeric weather prediction models (e.g., Weather Research and Forecasting, WRF model) and downscaled reanalysis data.

Measured data are point-specific renewable energy data gathered by trained personnel and meteorological measuring equipment (such as meteorological towers). If data from multiple points are available across a region, these data can provide a reasonable understanding of the solar or wind resource for a region. These data can also be used for site-specific project assessments. Project developers may choose to work with institutions already collecting these data, such as airports (for wind data). Measured data can also be used in models, such as WRF described above.

Validations of data are typically performed at the time renewable energy resource data are created. Validation refers to comparing modeled data to "ground truth" data to quantify how closely the model matches reality. Validation can take many forms—for example, from a meteorological standpoint, comparing diurnal (daily) and annual cycles of wind speed; or from a power standpoint, comparing power output ramps and frequency distributions. Validation can play an important role in analysis application, sometimes warranting the use or purchase of additional data sets if the validation metrics point to systematic biases.

Text drawn from: https://www.nrel.gov/docs/fy18osti/68913.pdf

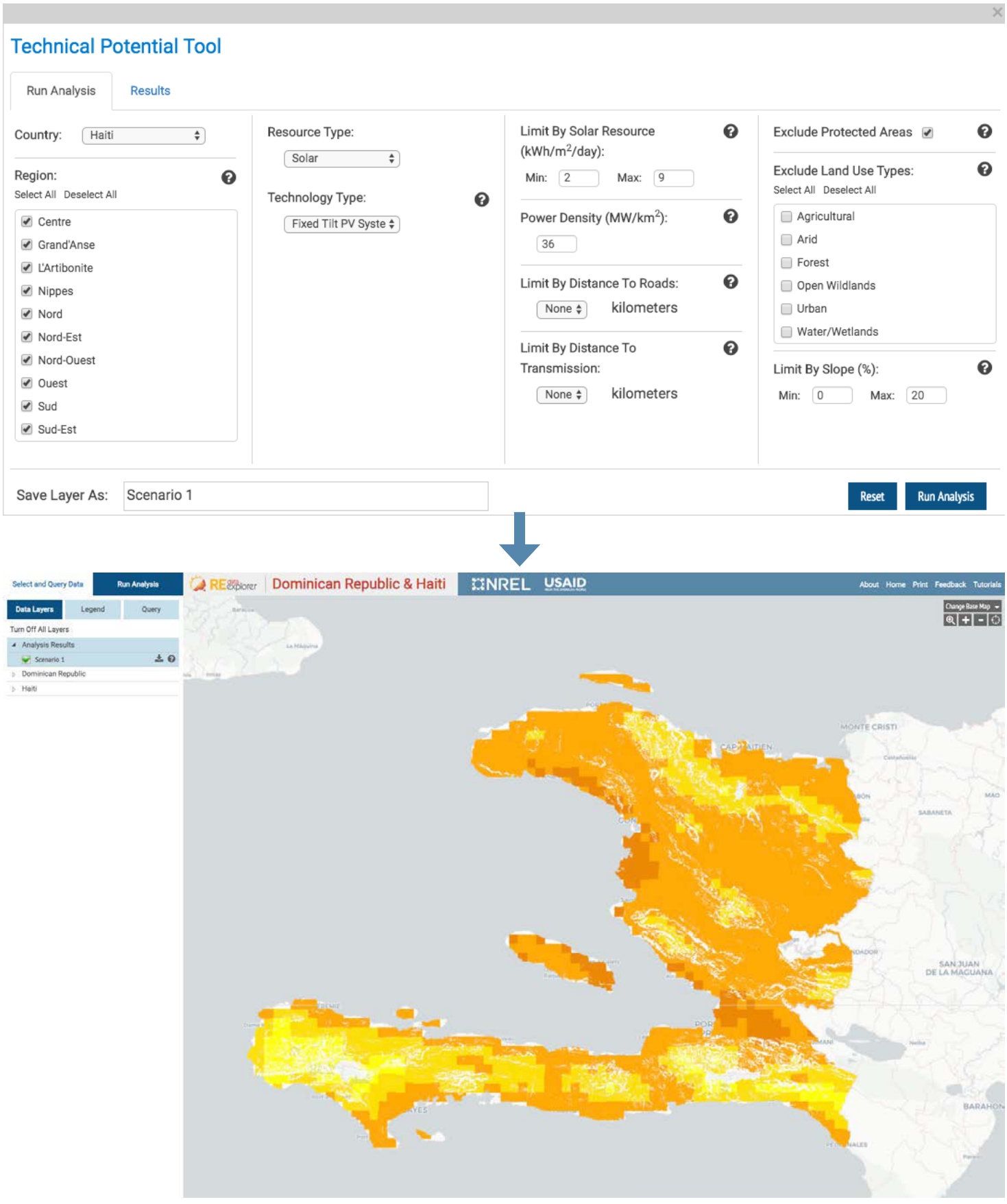

Figure 1: Technical potential analysis and visualization using the RE Data Explorer

grid, demand, existing generation, and borders for power export. Auction designers can also couple the use of more granular tools, such as the System Advisor Model (SAM), with the technical potential and visualization tools to better understand the potential project economics. The RE Data Explorer is also a repository for the solar and wind time series data required for these analyses.

Policymakers may choose to purchase the land that is identified to have the highest renewable energy potential, removing land rights issues as a potential obstacle for developers. This was the approach taken in Kazakhstan where an early auction process ran into challenges and uncertainties with land ownership. Box 3 presents key ways the RE Data Explorer supported Kazakhstan's auction process.[3]

In many markets, auction designers choose to specify a capacity goal (megawatts) of renewable energy to be developed under the auction process. The government or the utility then chooses winning bids until the total capacity of the accepted bids exceeds the capacity goal. In these cases, RE Data Explorer can inform high-level renewable energy capacity goals that inform the auction process.

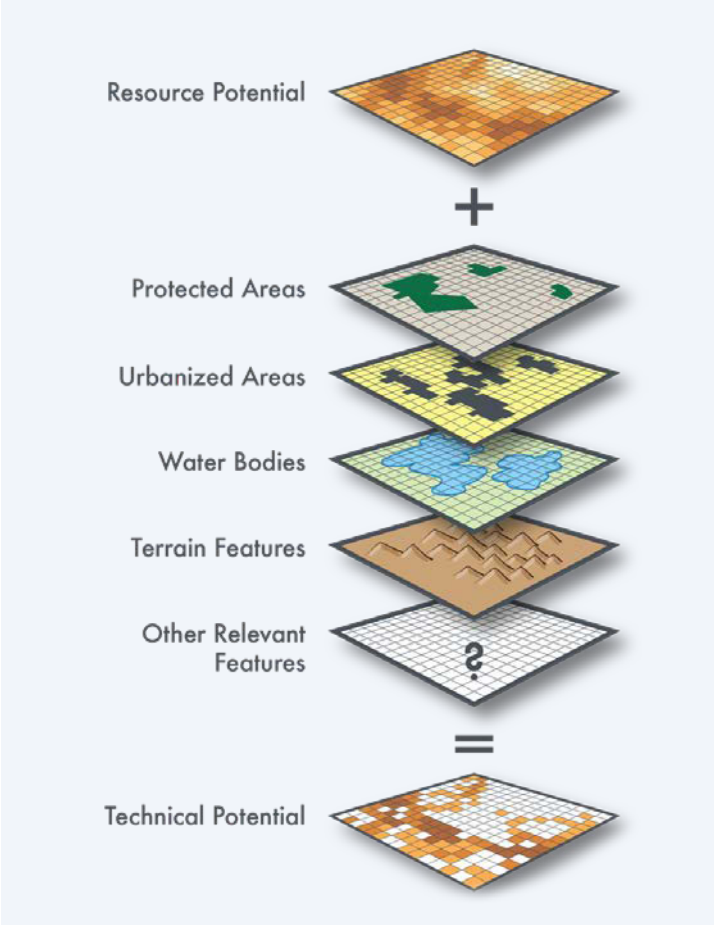

Figure 2. Analyzing technical potential for renewable energy
Source: https://www.nrel.gov/docs/fy19osti/72995.pdf

Additionally, RE Data Explorer can also be used with other geospatial and techno-economic tools to compare across many analytic results (related to resource potential, cost, and economics, and so on) and improve the overall robustness of an auction process.

For the Southeast Asia region, the RE Data Explorer also includes a Cost of Energy Mapping Tool. The tool provides another important analysis capability to support auction design and participating renewable energy project developers. Specifically, the tool provides high-quality data and spatial analysis (1 km by 1 km resolution) of the cost of utility-scale wind and solar PV generation in select countries. Generation costs are expressed as the levelized cost of energy (LCOE), a commonly used metric that represents the net present value of the unit cost of electricity (U.S. Dollar, or local currency, per megawatt hour) during the lifetime of a particular electricity generation technology. Simply, LCOE is a first-cut estimate of the "breakeven" price of power that would cover a generator's lifetime costs. It also allows for the comparison of different generation technologies (such as hydropower or thermal generation) by a common metric. Auction designers can use the tool and analysis as a key input to identify potential feasibility from a high-level economic perspective. In particular, auction designers can use the tool to estimate the capacity of renewable energy (megawatts) potentially available at or below a specific cost to help inform auction design and evaluation of sites for renewable energy development.

Informing Bids

Private developers often use several data sets and tools to fully assess the feasibility of a renewable energy project. Comparing multiple data sets and analyses is a very important aspect of due diligence in preparing a project bid under an auction process. As countries are beginning to build renewable energy markets, even before an auction is put in place, the RE Data Explorer can be used by the government and/or utility to build private sector interest. Presenting RE Data Explorer on the Ministry of Energy website, or as part of the competitive tender, allows private developers and other funders to access the tool and data to support high-level prospecting of renewable energy opportunities.

Within a competitive tender, auction designers can also point developers to the RE Data Explorer to understand the site selection process (in relevant cases), and to inform bids. In particular, the open time series data repository aspect of the RE Data Explorer (or the Data Download Tool) can be particularly useful for developers. Project developers can download these data to feed into more specific techno-economic models and renewable energy system

[3]A full case study of this process is available here: https://www.re-explorer.org/assets/pdfs/74216.pdf.

Box 3. Kazakhstan's First Renewable Energy Auction and the RE Data Explorer

The RE Data Explorer was used to support design and implementation of Kazakhstan's first competitive renewable energy auction process in 2018. This auction resulted in 170MW of solar and 400MW of wind projects being awarded power purchase contracts.

The technical potential tool within the RE Data Explorer was used to assess potential locations for solar and wind energy auction rounds and to inform government land purchases for renewable energy development. The analysis helped decision-makers in Kazakhstan to narrow down areas with good solar and/or wind resources, suitable land area, and proximity to demand centers and transmission infrastructure. The Data Download Tool within the RE Data Explorer provided, and continues to provide, access to high-quality modeled wind resource data (15-minute temporal resolution at 3km by 3km geographic resolution) in Kazakhstan including wind speed, wind direction, air pressure, and temperature at heights from 80-120 meters. Solar irradiance time series data is also available within the tool. Project developers, government agencies, and other power system stakeholders can download these data free-of-charge. In some cases, the data were used with NREL's System Advisor Model to estimate the energy generation potential and financial performance of wind and solar energy projects in specific locations. These analyses then informed Kazakhstan's overall auction process and project developers bids. To learn more, visit: https://www.re-explorer.org/assets/pdfs/74216.pdf.

Photo credit: First Wind Power Plant LLP with permission of the Financial Settlements Center of Renewable Energy LLP.

and financial tools and compare results across other datasets that are purchased or publicly available. Use of tools and data, such as the RE Data Explorer time series data, can be documented within bids to inform choice of winning bids.

The Cost of Energy Mapping tool, described above, can also support project developers in further evaluating sites for renewable energy development under an auction process through providing information on capacity of renewable energy potentially available at or below a specific cost (U.S. Dollars, or local currency, per megawatt hour) in a specified area.

Conclusion

The RE Data Explorer can support several stages of a renewable energy auction process. The tool was used to inform Kazakhstan's successful 2018 renewable energy auction. It is anticipated that lessons from Kazakhstan's process and the guidance in this document will support a broader set of countries in developing renewable energy auctions with support from the RE Data Explorer. Overall, providing easy access to a common database and starting point for high-quality renewable energy and complementary data, as well as analysis tools, can support a transparent, equitable auction process and benefit several stakeholders, including auction designers and project developers.

Written by Sadie Cox, Nathan Lee, Haiku Sky, National Renewable Energy Laboratory

www.re-explorer.org | www.nrel.gov/usaid-partnership

Jeremy Foster
U.S. Agency for International Development
Email: jfoster@usaid.gov

Sarah Lawson
U.S. Agency for International Development
Email: slawson@usaid.gov

Sadie Cox
National Renewable Energy Laboratory
Email: sadie.cox@nrel.gov

This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-17-2050. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID.

NREL/TP-6A20-76414 | April 2020
NREL prints on paper that contains recycled content.

Renewable Energy (RE) Explorer provides renewable energy data, geospatial analysis tools, and technical assistance to support data-driven renewable energy decision making. The RE Explorer was developed by the National Renewable Energy Laboratory and are supported by the U.S. Agency for International Development.

The USAID-NREL Partnership addresses critical challenges to scaling up advanced energy systems through global tools and technical assistance, including the Renewable Energy Data Explorer, Greening the Grid, the International Jobs and Economic Development Impacts tool, and the Resilient Energy Platform. More information can be found at: **www.nrel.gov/usaid-partnership**.

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

REexplorer MAPPING OUR ENERGY FUTURE

Greening the Grid

I-JEDI

Resilient Energy Platform