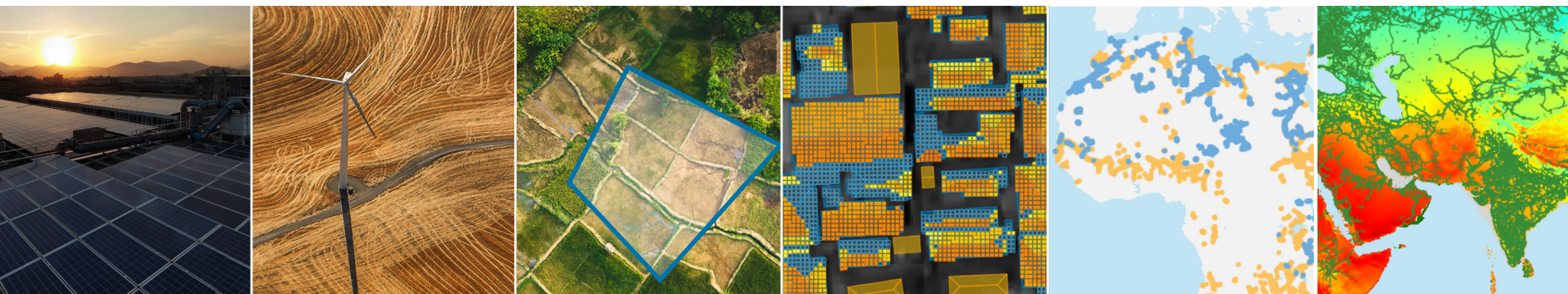


GLOBAL ATLAS FOR RENEWABLE ENERGY INITIATIVE

10+ YEARS IN THE MAKING



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ABOUT IRENA

The International Renewable Energy Agency (IRENA) serves as the principal platform for international co-operation, a centre of excellence, a repository of policy, technology, resource and financial knowledge, and a driver of action on the ground to advance the transformation of the global energy system. A global intergovernmental organisation established in 2011, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security, and low-carbon economic growth and prosperity.

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ABBREVIATIONS

- GIS** geographic information system
- IRENA** International Renewable Energy Agency
- NDC** Nationally Determined Contributions
- PV** photovoltaic
- REmap** Renewable Energy Roadmap



EXECUTIVE SUMMARY

Climate change is now taking an increasing toll across the globe. The world must therefore accelerate efforts to reduce carbon dioxide and other greenhouse gas emissions by transitioning to renewable energy.

While some countries have made considerable progress in adopting energy systems based on renewables, many others, especially those in the developing world, lag behind – even though many of them possess large renewable resources. North African nations, for example, have vast potential for generating solar energy. These countries and others could take advantage of renewable resources to generate affordable, reliable electricity for their own needs, while meeting their development and emission reduction goals. In addition, they could also become exporters of electricity, bringing significant economic benefits to their countries.

A major reason why many developing nations have yet to realise their potential for renewable energy development is that they lack the data, expertise and financial support needed to evaluate and develop their national renewable energy potential; whereas other nations can take advantage of opportunities to decarbonise because of the knowledge and support they have.

The Global Atlas for Renewable Energy is designed to close this gap, helping all countries around the world realise the many benefits of renewable energy development.

The Global Atlas stems from an initiative launched in 2009 by the International Renewable Energy Agency (IRENA), in partnership with the Clean Energy Ministerial Multilateral Solar and Wind Working Group. It is designed to help countries identify the best locations for renewable energy development and to reduce the risks of that development, thus increasing access to capital and spurring renewable energy investments. The countries would then be able to increase the share of renewables in their energy systems and work towards meeting their Nationally Determined Contributions. This would also help them achieve the economic and societal benefits of increased production of affordable and reliable low- or zero-carbon energy, while accelerating the global energy transition.

The core of the Global Atlas initiative is a platform that uses open-source architecture and existing databases to map and assess renewable energy resources anywhere in the world. This platform provides actionable information on such key parameters as wind speeds, annual solar irradiation, areas available for renewable energy development, population growth and relationships to existing grid infrastructure. Since its creation in 2013, the platform has been updated and expanded with inputs from more than 50 international research institutions and 39 countries.

To make this initiative as useful and inclusive as possible, IRENA has developed five technical online tools and analyses to support countries in tackling challenges related to renewable energy project planning and development:

- 1. Zoning assessment.** This assessment maps a country's investment opportunities for developing utility-scale solar PV and onshore wind projects, with a focus on their technical and financial perspective. It uses high-quality resource and meteorological data, such as the amount of annual and hourly solar irradiation, along with ancillary data on local population density, protected areas, topography, land use, power transmission lines networks, road networks, costs (capital and operational) and technological parameters. In addition, it takes into account country-specific renewable energy strategies, thus allowing the identification of zones that might offer the most promising sites for development of a country's renewable energy deployment plan.
- 2. Bioenergy simulator.** This tool evaluates numerous possible combinations of biomass types, technologies and end uses. It estimates the potential bioenergy production needed for generating electricity, for heating and for transportation, and calculates the amount of solid, liquid or gaseous biofuel that would be produced. It also flags potential issues, such as the presence of protected areas or inadequate water supply.
- 3. Site assessment.** This assessment identifies financially viable locations for solar (onshore photovoltaic (PV), floating PV, and concentrated solar power) and wind (onshore and offshore) project development within a country. In addition to information on the renewable resource itself, the assessment uses meteorological data, site-specific features (surface roughness, orography and terrain type), technology-specific information and appropriate financial parameters (investment and operation costs). It also employs industry-standard energy yield models and approaches to capture the small-scale variability in renewable resource and meteorological data, providing a much more accurate pre-feasibility evaluation of prospective sites than have previous assessments.
- 4. SolarCity simulator.** This tool uses data from remote sensing and meteorology to create detailed three-dimensional images of buildings and to identify suitable rooftop areas for solar installation. The simulator then combines this information with data on the price of PV panels, the cost of installation, the expected amount of electricity generation and market conditions. The calculations thus help identify the locations where rooftop solar installations are technically and economically feasible. The simulator also estimates the total environmental and social benefits of these installations, both in terms of emissions reduction and economic gain.

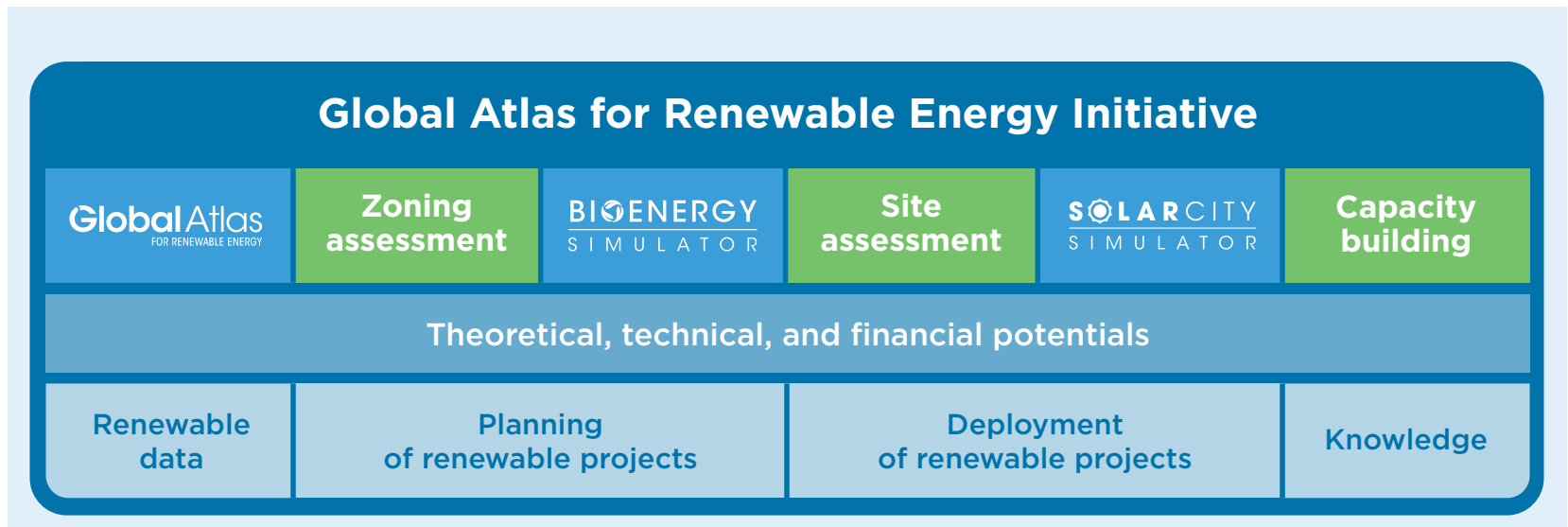
In addition to these online tools and assessments in the Global Atlas, IRENA addresses the problem of lack of capacity in government ministries or agencies, public utilities and other local authorities. It does so by offering capacity-building workshops for local authorities, along with webinars for the general public. These workshops and webinars are specifically designed to fill gaps in the local knowledge and skills required for renewable energy resource assessment. They help participants use the tools in the Global Atlas to better assess and harness their renewable energy potential and to move forward with renewable energy development.

Depending on the country context and local needs, these capacity-building and training workshops can illuminate the general Global Atlas platform and datasets, the process of assessing the local potential for bioenergy, the assessment of the potential for rooftop solar PV in cities using the SolarCity simulator, the investment opportunities for solar PV and onshore wind projects, or pre-feasibility site assessments for project development.

The Global Atlas for Renewable Energy has been used extensively over the past decade. The initiative has gathered more than 1 000 renewable energy maps – covering solar, wind, bioenergy, geothermal, hydropower and marine energy. It has produced a number of site assessment reports, identifying the potential for utility-scale solar and wind development in Burkina Faso, Mauritania, Mali, El Salvador and other countries. It has also assessed the potential for wind and solar investments in West Africa, Latin America and the Gulf Cooperation Council states, among others. The Global Atlas has become an important asset for IRENA, aiding analyses of renewable energy markets, grid integration and stability, and renewable energy road maps. It provides concrete evidence that adding renewable energy, both in traditional power systems and off-grid situations, is feasible, affordable and efficient.



Resource Potential Assessment Platforms and services





INTRODUCTION

There is an urgent need to reduce carbon emissions and other greenhouse gases causing global warming, with the goal of achieving net-zero emissions by 2050. While this is a daunting task, reports and analyses from the International Renewable Energy Agency (IRENA) and many other organisations show that there are technologically feasible and economically affordable pathways to successful decarbonisation. These pathways rest on three pillars:

1. Electrify everything possible, from transportation to heating and cooling systems in buildings.
2. Produce that electricity from renewable sources, like wind, solar and hydro.
3. Increase energy efficiency wherever possible.

Some countries in the developed world have made considerable progress towards creating energy systems based on renewables. Denmark, for instance, now generates more than half of its electricity from wind, solar and biomass.

However, many other countries, especially those in the developing world, are lagging in the development of renewables – even though many of them possess large renewable resources. African nations in the Sub-Saharan region, such as Mauritania and Burkina Faso, for example, have vast potential for solar energy. These countries, and others, could take advantage of those resources to not only meet their own needs for affordable and reliable electricity and reach their development and emission reduction goals, but also become exporters of electricity.

A key reason why some developing countries have yet to realise their renewable energy potential is that they lack the data, expertise and financial support needed to assess and develop this potential. As a result, there is a huge gap between nations that can take advantage of opportunities to decarbonise and those that face the abovementioned barriers. This gap makes it more difficult for the world to reduce the threat of climate change by rapidly lowering greenhouse gas emissions. Equally important, it also means that countries without the necessary information and support are missing out on major opportunities for development and economic growth.

Given the recent large decline in the costs of wind and solar PV renewable electricity generation, large-scale deployment of these technologies, including city-scale deployment of rooftop solar PV systems, could bring affordable, reliable electricity to billions of people around the world who currently lack access. This, in turn, would unleash a host of economic and entrepreneurial opportunities – such as more agricultural processing within rural communities – resulting in economic growth that lifts more people out of poverty, reduces hunger and undernourishment, raises incomes and living standards, and reduces inequities and conflicts. Increased deployment of renewable energy would also prevent countries from locking into high-carbon, polluting growth models, and even enable some developing nations to become exporters of clean energy.

The [Global Atlas for Renewable Energy initiative](#)¹ is designed to help many developing nations unlock their enormous potential to generate large amounts of affordable clean electricity.

¹ An initiative is the first in a series of actions intended to solve a problem, with the hope that it will continue.



GLOBAL ATLAS FOR RENEWABLE ENERGY INITIATIVE

The Global Atlas for Renewable Energy (“Global Atlas”) is an initiative of IRENA, in partnership with the Clean Energy Ministerial Multilateral Solar and Wind Working Group, to help countries realise their potential for renewable energy development.

Since its inception in 2012, the initiative has assisted policy makers, project developers, investors and the global community by providing:

- A single, free online repository that assembles and collates existing renewable energy resources and related supplementary datasets for understanding the renewable potential of a region or country;
- Online tools, such as the Bioenergy and SolarCity simulators, that estimate the technical and financial potential of a specific renewable resource for planning and developing projects;
- Country-level technical analyses, such as zoning and site assessments, that assess the technical and financial potential of a country with the intent of identifying opportunities for renewable energy project planning and deployment; and
- Capacity-building and training workshops that facilitate knowledge sharing about the benefits of renewable energy development and assessing the renewable potential in countries.

The initiative aims to reduce the risks of investment in renewable energy projects, increase access to capital and spur renewable energy investments. This would help countries increase the share of renewables in their energy systems, progress towards meeting their Nationally Determined Contribution (NDC) commitments and achieve the potentially enormous economic and societal benefits stemming from increased production of affordable and reliable low- or zero-carbon energy.

The mission of the Global Atlas for Renewable Energy is to close the gap between nations that already have access to the necessary data, tools and expertise to evaluate their national renewable energy potential, and those lacking such elements.

Countries contributing to the initiative

Albania, Australia, Austria, Belarus, Belgium, Colombia, Denmark, Egypt, Eswatini, Ethiopia, Fiji, France, the Gambia, Germany, Grenada, Greece, Honduras, India, the Islamic Republic of Iran, Israel, Iraq, Italy, Kazakhstan, Kenya, Kiribati, Kuwait, Lithuania, Luxembourg, Maldives, Mali, Mauritania, Mauritius, Mexico, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nicaragua, Niger, Nigeria, Norway, Peru, the Philippines, Poland, Portugal, Qatar, Rwanda, Saudi Arabia, Senegal, Seychelles, South Africa, Spain, Sudan, Switzerland, the United Republic of Tanzania, Tonga, Tunisia, Uganda, the United Arab Emirates, the United Kingdom, the United States of America, Uruguay, Vanuatu, Yemen and Zimbabwe.

2.1 THE GLOBAL ATLAS FOR RENEWABLE ENERGY PLATFORM

The Global Atlas for Renewable Energy is a free web-based geographic information system (GIS) platform² that allows its users – policy makers, practitioners and business developers – to:

- Display and screen more than 1000 high-quality renewable resources datasets – solar, wind, bioenergy, geothermal, hydropower and marine – from more than 40 highly skilled international research institutions, such as the US National Renewable Energy Laboratory, European Space Agency, Technical University of Denmark, Delft University of Technology (TU-Delft) and Food and Agriculture Organization (see Annex for full list) to identify areas of high potential.
- Overlay ancillary information – roads, power lines, protected areas, population density and topography – on renewable resource datasets to locate areas of opportunity where further assessments can be relevant.
- Connect to external data sources and exchange information.
- Access recommended advanced tools – SolarCity and Bioenergy simulators – to evaluate the technical and financial potential for renewable energy planning and development, and estimate the possible renewable resources' contributions in transport, heating and electricity.

Since 2012, IRENA has developed the Global Atlas using open standards and technologies to ensure data sharing and interoperability. Further, the platform has been carefully designed to enable users to interact with the data in a user-friendly manner.

The Global Atlas' latest releases – Version 4.0 in 2021 and Version 4.1 in 2023 – have the most significant updates yet, which allow users to:

- Visualise and manipulate up-to-date renewable resources and ancillary datasets using enhanced functionalities – retrieve data in two modes, clip data over selected areas, make drawings on the map, save layers, share maps on social media, download datasets for offline analysis, etc.
- Download long-term hourly re-analysis datasets from the European Centre for Medium-Range Weather Forecasts' ERA5 (fifth-generation global atmospheric re-analysis) and the National Aeronautics and Space Administration's MERRA2 (Modern-Era Retrospective Analysis for Research and Applications, Version 2).
- Visualise and comprehend investment opportunities – the best zones with their corresponding generation profiles and associated attributes – for deploying solar PV and onshore wind projects to plan project development and set targets.

IRENA welcomes continuous feedback and expert inputs to the platform. Reach out to get more information, provide feedback, share your experience or suggest datasets to integrate into the platform (GARE@irena.org).

² A web-based platform is software that offers reciprocal engagement with interactions between a platform and its users generating personalised experiences, or a software system that allows users to register and interact with the application.

Global Atlas
FOR RENEWABLE ENERGY

globalatlas.irena.org

IRENA
International Renewable Energy Agency

40+
international institutions contributed

Renewable potential assessment of an area
Topography Transmission Road network

Mapping investment opportunities for developing utility-scale solar and wind projects

Feedback from Global Atlas users

“... this type of information can help stimulate favourable renewable energy policy development and national targets ... a centralised updated data source backed by peer reviews and uncertainty estimates reduce the time required to evaluate potential sites for project development and will reduce the upfront costs of project planning.” **(Dr Dave Renee, Past President of the International Solar Energy Society)**

“The Global Renewable Energy Atlas is one of the most important initiatives led by IRENA.” **(Mr Maged K. Mahmoud, Senior Expert, Regional Center for Renewable Energy and Energy Efficiency)**

“The atlas is a great tool that contains a vast pool of very useful resources.” **(Global Atlas user)**

“The user interface of Global Atlas is so wonderful.” **(Global Atlas user)**

“Kudos for the new version. It seems to be intuitive and lean.” **(Global Atlas user)**

2.2 THE ZONING ASSESSMENT

The zoning assessment is a GIS-based multi-criteria decision analysis, developed as part of the Global Atlas for Renewable Energy initiative. It aims to map investment opportunities for developing utility-scale solar PV or wind projects. This will help plan energy generation and transmission expansion, set NDC targets, and develop and implement national energy master plans.

The assessment is conducted via a rigorous and interactive process involving official representatives from a country, with due consideration being given to the country's local conditions. It provides the mapping of:

- Highly attractive zones for investment in renewable project development; and
- Techno-economic zones' attributes, which include installed capacities, capacity factors, potential hourly and annual energy generation, storage sizes and capacities, levelised cost of energy and other factors.

Global Atlas
FOR RENEWABLE ENERGY

Zoning assessment

Supporting countries in planning
of renewable energy development

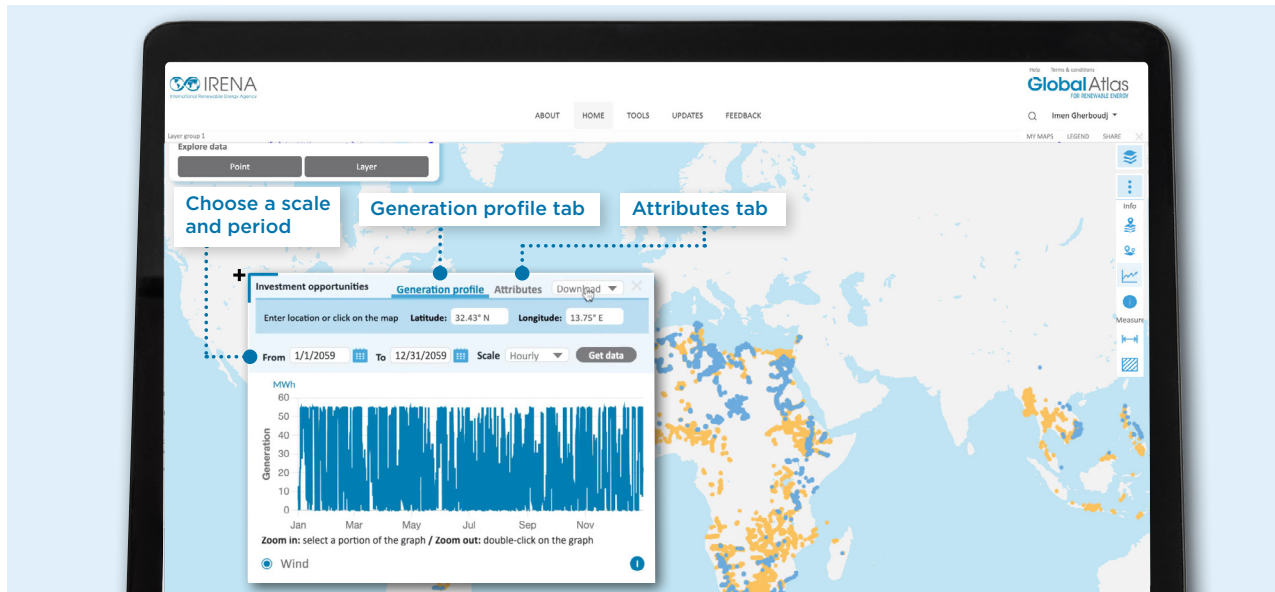
- Mapping best zones
- Calculating generation profiles
- Calculating investment potential
- Enabling decision making

Service designed to identify opportunities
for planning solar and wind energy projects

IRENA
International Renewable Energy Agency

The methodology relies on high-quality resources and meteorological data (both annual average and hourly), while also accounting for ancillary data on local population density, protected areas, topography, land use, power transmission lines' networks, road networks, costs (capital and operational) and technological parameters. These criteria are adapted to a specific country's renewable energy strategy, thus allowing the identification of the most promising zones for prioritisation in the renewable deployment plan.

This analysis has assisted local authorities – ministries and public utilities – in several countries in Africa and the Middle East, and in Colombia and El Salvador in Latin America. It has supported several IRENA studies, such as the Renewable Energy Market Analysis and the Renewable Energy Roadmap (REmap) for Southeast Europe.



The development is initiated through an official request from the country to IRENA. Subject to the availability of funds, IRENA:

- Liaises with the country focal point to collect all requirements to account for local conditions;
- Maps the investment opportunities and delivers a report elaborating the results; and
- Provides a tailored training workshop on renewable potential assessment with documentation.

IRENA welcomes continuous feedback and expert inputs. Contact IRENA to get more information or provide feedback (GARE@irena.org).

2.3 THE BIOENERGY SIMULATOR

The **Bioenergy Simulator** is a free user-friendly web-based application³ developed in 2017 as part of the **Global Atlas for Renewable Energy Initiative**. It aims to raise awareness of modern bioenergy production options to help decarbonise the world's energy system, meet global climate goals and ensure access to affordable, reliable and sustainable energy.

The simulator allows users – policy makers, practitioners and business developers – to determine and understand relevant bioenergy pathways in a selected area by assessing:

- Total bioenergy production for electricity, heating and transport fuels for different combinations (biomass resources, technologies and energy efficiency conversion factors);
- Relevant sustainability concerns related to protected areas, water scarcity and population density; and
- Possible applications of the simulated bioenergy potential in the area.

BIOENERGY SIMULATOR
biosimulator.irena.org

IRENA
International Renewable Energy Agency

Parameter	Value	Unit
Total fuel production	22.2	t/ha
Crop average yield	None	None
Total crop production		t
Biomethane yield		m³/ha
Biomethane heat production		MJ
Bioenergy yield		t/ha
Total bioenergy production		GJ
Gross bioenergy production		MJ/ha
Gross heat production		MWh
Gross bioenergy to biogas		t/year
Possible application		

Developed to unlock the potential of bioenergy

- An area
- Biomass resource
- Technology
- End-use

³ A **web-based application** is software stored on a remote server and delivered over the internet through a browser interface.

The simulator combines existing geospatial datasets, technical parameters and models to provide a preliminary assessment of the bioenergy potential within a selected area.⁴ The resulting conversion **values are to be taken as suggestions**; however, users are able to edit the default values when more accurate data are available. The assessment is conducted considering numerous combinations of biomass resources (crops, agricultural residue, livestock waste and forest plantation residue), technologies (anaerobic digestion, combustion, gasification and hydrolysis-fermentation), end uses (electricity, heating and transport) and energy efficiency conversion factors. It is important to highlight that the current version of the tool provides this knowledge without assessing the financial viability, the socio-economic feasibility or the environmental impact. Further, potential developers need to seek certification schemes from recognised bodies to guarantee sustainable development.

The current version of the Bioenergy Simulator – Version 2.0 – includes updated datasets, an improved methodology and a revamped user-friendly design that enables users to:

- Visualise the bioenergy resource and ancillary datasets obtained through the Global Atlas.
- Assess the potential bioenergy production for new biomass resources – such as municipal solid waste and forest plantation residue.
- Fine-tune the simulations by considering extra input parameters.

IRENA welcomes continuous feedback and expert inputs to improve the simulator methodology. Contact IRENA to get more information, provide feedback and share your experience (GARE@irena.org).

Feedback from Global Atlas users

“The new version of the Bioenergy Simulator, with its appealing and graphically intuitive online interface, is a tool with high potential for applicability. It provides great support for the bioenergy sector, giving useful overviews and outcomes both for private and public sectors, with possible geographic coverage at the global level.” **(Andrea Colantoni, Associate Professor, Tuscia University, Italy)**

⁴ Key datasets used by the Bioenergy Simulator include the Global Agro-Ecological Zones by the International Institute of Applied Systems Analysis/Food and Agriculture Organization; the Guidelines for National Greenhouse Gas Inventories by the Intergovernmental Panel on Climate Change (2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories); the Food and Agriculture Organization’s Planted Forests Database [2003] by M. Varmola and A. Del Lungo); the Encyclopaedia of Forest Trees 2013 by the Centre for Agriculture and Bioscience International; the Global Road Network by OpenStreetMap; the Water Scarcity Risk by the World Research Institute and the World Database for Protected Areas by the UN Environment Programme World Conservation Monitoring Centre. The default values for the input parameters come from an extensive literature review of the most common value chains for bioenergy production and use.

2.4 PRE-FEASIBILITY SITE ASSESSMENT

Site assessment is a cost-effective pre-feasibility analysis developed as part of the Global Atlas for Renewable Energy initiative. It aims to support countries in finding economically viable sites for solar (PV, parabolic trough collector, central receiver system and linear Fresnel) and wind (onshore and offshore) project development. This de-risks investments and expedites the project development process

The assessment is conducted in close consultation with country representatives and provides:

- **Technical feasibility**, which includes the net annual energy production of the site considering losses and uncertainty.
- **Financial feasibility**, which includes the tariffs and levelised costs that make a site viable for project development.

The infographic features a background image of a solar farm with a wind turbine under a sunset sky. On the left, a blue box contains the 'Global Atlas FOR RENEWABLE ENERGY' logo and the text 'Site assessment Supporting countries in deployment of renewable projects'. On the right, two callouts with icons describe 'Energy yield assessment' (lightning bolt icon) and 'Financial viability assessments' (dollar sign icon). At the bottom, a white box contains icons for solar and wind, followed by the text 'Pre-feasibility assessment service designed to screen viable sites for solar and wind project development in countries'. The IRENA logo is in the bottom right corner.

Global Atlas
FOR RENEWABLE ENERGY

Site assessment
Supporting countries in
deployment of renewable projects

Energy yield assessment

Financial viability assessments

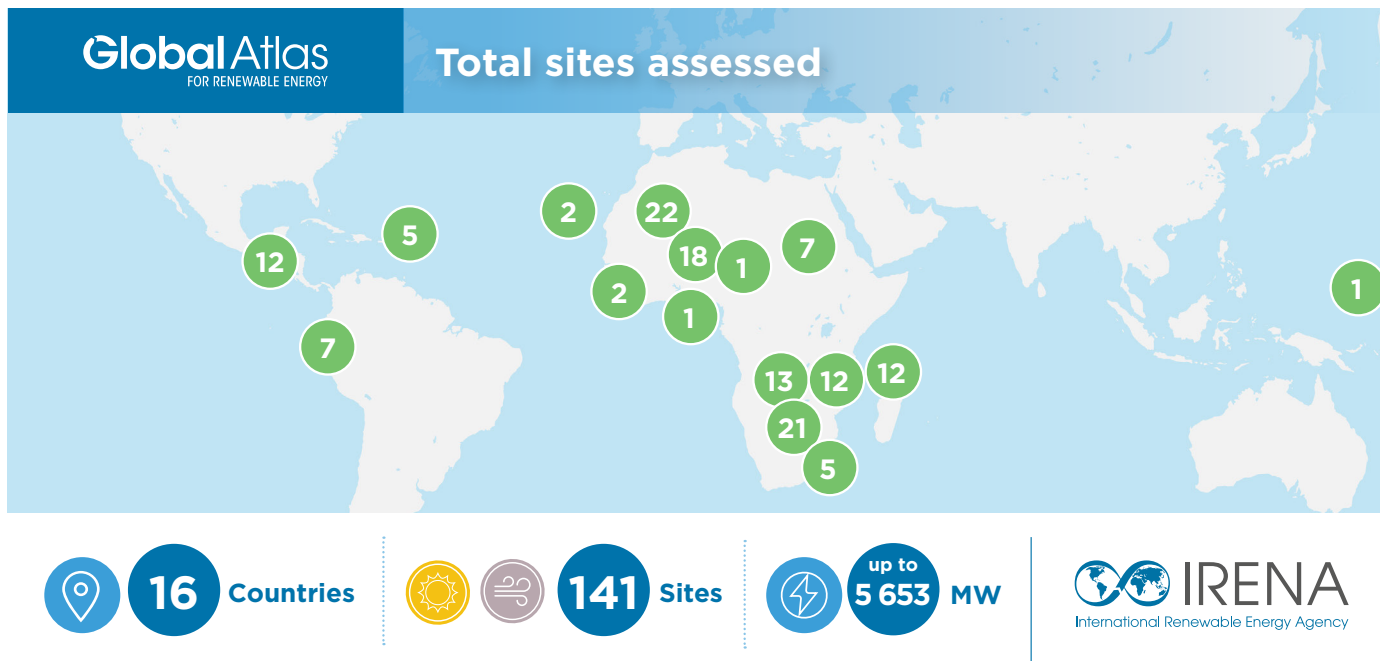
Pre-feasibility assessment service designed to screen viable sites for solar and wind project development in countries

IRENA
International Renewable Energy Agency

The methodology for site assessment uses industry-standard energy yield models and approaches that combine accurate information – namely high-quality renewable resources and meteorological data, site-specific features (surface roughness, orography and terrain type) and technology-specific information – with appropriate financial and fiscal parameters (investment and operation costs) to provide pre-feasibility evaluations of prospective sites. Each assessment distinguishes among:

- Non-viable sites that are feasible at significantly higher tariffs
- Viable sites that are feasible at lower tariffs
- Marginally viable sites that are feasible with contingent conditions

This analysis expedites the development process and increases the likelihood of success in finding economically viable sites for further investment. It has assisted local authorities (ministries and public utilities) in several countries in Africa, Latin America and small island developing states in screening more than 140 promising sites for solar and onshore wind power projects. The technical feasibility has also supported several IRENA studies, such as of grid integration and stability in Mozambique.



Site assessment is initiated through an official request from the country to IRENA. Subject to the availability of funds, IRENA:

- Liaises with the country focal point to collect all requirements;
- Assesses the sites and delivers a report elaborating on the result; and
- Provides a tailored training workshop on renewable resources and site assessment with documentation.

IRENA welcomes continuous feedback and expert inputs. Contact IRENA to get more information, provide feedback or share your experience with the service (GARE@irena.org).

Feedback from countries on the site assessment

Mali – “The site assessment will be very useful for our country, Mali. The analysis report will guide us in our decision-making.” *(Dr. Souleymane Berthe, Director General, Renewable Energy Agency of Mali, Ministry of Energy and Water, Mali).*

El Salvador – “IRENA’s site assessment is of paramount importance to the Directorate-General for Energy, Hydrocarbons and Mines, as it helps us to identify renewable energy sites, strengthen the project portfolio and look for possible financing.” *(Adonay Urrutia, Head of the Energy Planning and Statistics Division, Directorate of Energy, Hydrocarbons and Mines, El Salvador).*

Mozambique – “The site assessment was very helpful in selecting sites for the projects that are now in the feasibility study stage.” *(Eucides Dgedge, Ongrid Systems, Electricidade de Moçambique, E.P., Directorate of Renewable Energy and Energy Efficiency).*



2.5 THE SOLARCITY SIMULATOR

The **SolarCity Simulator** is an innovative free web-based application developed as part of the Global Atlas for Renewable Energy Initiative. It aims to support countries in accelerating the deployment of rooftop-mounted solar PV systems in selected urban areas by facilitating project planning and development, market development, target setting and policy design.



Developed to
**boost local rooftop
solar market**



Calculate electricity generation



Plan layout of rooftop PV systems



Find financing solutions and incentives

The simulator was developed in close collaboration with country representatives to give due consideration to each country's local conditions. For selected rooftop(s), the simulator allows users to assess:

- The technical potential, which includes mapping of suitable areas to install PV systems at a 1 square metre spatial resolution with an evaluation of the electricity production at different scales (hourly, daily and annual) for different installation scenarios (capacity, panel efficiency and storage).
- The financial potential, which includes a range of economic indicators such as payback to equity, equity internal rate of return and investment cash flow from three perspectives (homeowners, investors and governments).
- The impact of different policy interventions, including feed-in tariffs, subsidies, tax credits and net metering, on the rooftop solar PV market. Users can also assess the associated social and environmental benefits, including the annual carbon emissions avoided, the equivalent number of tropical trees planted, the equivalent number of cars taken off the street when sourcing the electricity from rooftop solar PV systems and the number of jobs created.

The development methodology uses cutting-edge technologies and approaches, including high-resolution satellite imagery, advanced image processing techniques and web-GIS technologies. The prospects of generating electricity and financing a selected rooftop solar PV system are estimated considering the city's local context, including high-quality solar resource profiles, 3D building footprints (building height, roof tilt and orientation) and financial parameters – investment cost, operation cost and fiscal parameters.

This methodology has been deployed cost-effectively in several cities worldwide, including in locations where solar potential is high but not yet fully evaluated. The simulator was first used to analyse the district of Kasese in Uganda. It has since been upgraded and scaled up for application in other cities and geographies, including the coastlines of Antigua and Barbuda; San Salvador in El Salvador; Bamako in Mali; Chongli in China; Port Louis in Mauritius; Ulaanbaatar in Mongolia; Port Louis in Mauritius; Simra-Birgunj in Nepal; three markets in Nigeria; Castries in Saint Lucia; São Tomé in São Tomé and Príncipe; Victoria in the Seychelles; Khartoum in Sudan; Sahinbey in Türkiye and Abu Dhabi in the United Arab Emirates. By early 2024, IRENA will have supported 31 cities worldwide.

The development is initiated through an official request from the country to IRENA. Subject to the availability of funds, IRENA:

- Liaises with the country focal point to collect all requirements reflecting the local context;
- Develops and releases the simulator for the concerned city online;
- Provides a training workshop on the simulator – focusing on the methodology its and demonstration, with documentation; and
- Liaises with the country to update online input parameters.

IRENA welcomes continuous feedback and expert inputs. Contact IRENA to get more information, provide feedback or share your experience on how the simulator led to meeting your goal of installing a PV system or designing a solar programme (GARE@irena.org).

Feedback from countries on the SolarCity simulator

Port Louis, Mauritius – “In its energy transition, Mauritius has set ambitious targets to achieve 60 percent of renewables in its electricity mix by 2030. The country has already installed over 100 MW of solar PV systems. The SolarCity simulator will help Mauritius to further increase electricity production by best siting the rooftop PV systems in the Port Louis region.” **(Government of Mauritius)**

San Salvador, El Salvador – “The SolarCity Simulator will help us to boost PV power generation for self-consumption in industry and commerce, which will contribute to achieving our 100% Renewable Energy target. It will also help the community and the government to assess the potential savings of using rooftop solar PV systems.” **(Juan Carlos Guevara, Energy Director, Directorate of Energy, Hydrocarbons and Mines, El Salvador)**

São Tomé, São Tomé and Príncipe – “The SolarCity software is an important tool that will allow us to quickly get an estimation of the technical and financial potential for deploying rooftop solar PV system in capital. Government could develop and implement self-generation policies at building level more viably and more quickly.” **(Belizardo Neto – Executive Technician, Ministry of Infrastructures, Natural Resources and Environment, São Tomé)**



2.6 CAPACITY-BUILDING AND TRAINING WORKSHOPS

One key barrier to renewable energy development and to the use of the Global Atlas’s tools and analyses in many countries is a lack of capacity in government ministries or agencies, public utilities and other local authorities. To overcome this barrier, IRENA offers capacity-building workshops for those local authorities, along with webinars for the general public. These workshops and webinars are specifically designed to fill any gaps in the local knowledge and skills required for renewable energy resource assessment. They enable participants to use the tools developed under the Global Atlas for Renewable Energy initiative to better assess and harness their renewable energy potential and to move forward with renewable energy development. The workshops and webinars also help foster knowledge exchange and build partnerships.

Depending on the country context and local needs, these workshops can cover a range of subjects for the benefit of participants – the general Global Atlas platform and datasets, the process of assessing the local potential for bioenergy, the assessment of the potential for rooftop solar PV in cities using the SolarCity simulator, the investment opportunities for solar PV and onshore wind projects, or site assessments for project development.

IRENA welcomes continuous feedback and expert inputs. Contact IRENA to get more information, provide feedback or share your experience with the service (GARE@irena.org).

IRENA
International Renewable Energy Agency

Capacity development workshops

Better understanding of renewable energy potential

- Global Atlas platform and datasets
- Assessment of local potential for bioenergy
- Assessment of solar PV potential in cities
- Assessment of investment opportunities
- Site assessments for project development

Workshops and webinars are designed to fill any gaps in the local knowledge and skills required for renewable energy resource assessment

Examples of IRENA workshops on renewable resource assessment

São Tomé and Príncipe – IRENA held an onsite workshop in São Tomé on 5 October 2022, to present the SolarCity simulator developed for the city to country representatives and stakeholders. During the workshop, participants learned about the features and capabilities of the simulator, including relevant information for solar energy planning and decision making. Stakeholders and representatives from São Tomé and Príncipe discussed how to leverage this tool for sustainable energy development, policy formulation and project planning within the country.

Pan-Arab Clean Energy (PACE) project – In February 2022, IRENA held an online workshop on “Improving Resource Assessment Practice for Arab Region: A Solution to Streamline Early-Stage Solar and Wind Planning”. During the session, participants from all Arab states learned about the renewable potential assessment, the Global Atlas platform and investment opportunities for developing solar PV and wind projects in their countries with the maximum development potential. Stakeholders and representatives from the countries compared the results with their ongoing projects and plans for new developments.





CONCLUSION

Climate change is one of the greatest challenges of our time. Nations around the world must rapidly decarbonise if humans are to avoid the potentially catastrophic impacts of a warming planet. But while some countries have made considerable progress transitioning to renewable energy, many others, especially those in the developing world, are lagging – even though many of them possess large renewable resources. A key reason is that they lack the data, expertise and financial support needed to evaluate and develop their national renewable energy potential. This lack not only hampers economic and social development, but also makes it harder to solve the global problem of climate change.

The Global Atlas for Renewable Energy initiative is designed to address this problem by helping all countries around the world realise the many benefits of renewable energy development. The platform uses detailed information from a wide variety of databases, along with modelling tools, to map and assess renewable energy resources anywhere in the world.

As documented by the testimonials in this report, the Global Atlas has proven to be useful for many countries. Over the past decade, the initiative has collated more than 1 000 renewable energy maps, supported several countries in making informed decisions on project sites and identified the potential for utility-scale solar and wind development in countries and regions ranging from Sudan to Colombia, and West Africa to Latin America. It has also become an important asset for IRENA, supporting analyses of markets, grid stability and renewable energy roadmaps. The atlas provides concrete evidence that transitioning to renewable energy is feasible, affordable and efficient – and crucial to meeting the global challenge of climate change.

Global Atlas
FOR RENEWABLE ENERGY

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ANNEX: DATA PROVIDERS AND CONTRIBUTORS TO THE GLOBAL ATLAS FOR RENEWABLE ENERGY INITIATIVE

 CENER NATIONAL RENEWABLE ENERGY CENTRE	 DLR	 جامعة خليفة Khalifa University	 REEEP	 REN21 RENEWABLES NOW	 UN environment United Nations Environment Programme	 UN WCMC environment programme
 ARMINES	 Australian National University	 CIAT	 Copernicus Europe's eyes on Earth	 ECMWF	 DTU Wind Energy Department of Wind Energy	 VORTEX
 CERREC ECREEE	 esa	 ESMAP Energy Sector Management Assistance Program	 FAO FIAT PANIS	 Joint Research Centre JRC	 GENERAL BATHYMETRIC CHART OF THE OCEANS GEBCO	 Consiglio Nazionale delle Ricerche
 Hot Dry Rocks Pty Ltd Geothermal Energy Consultants	 IDAE	 IGGGI Institute of Geosciences and Earth Resources	 IUGG IHFC INTERNATIONAL HEAT FLOW COMMISSION	 IUCN	 KIGAM	 Clean Power Research®
 Meteotest	 MINES PARIS PSL	 NASA	 NOVELTIS	 NREL Transforming ENERGY	 OAK RIDGE National Laboratory	 VISICOM®
 OpenStreetMap Foundation	 SODa Solar radiation Data www.soda-pro.com	 SOLARGIS	 THE WINDPOWER Wind Energy Market Intelligence	 THINK GEOENERGY	 TU Delft	





