Global Atlas
FOR RENEWABLE ENERGY

IRENA
International Renewable Energy Agency

A world of renewables

Middle East real relief. Elements of this image furnished by NASA©ixpert/Shutterstock

IRENA is an intergovernmental organisation that promotes the widespread adoption and sustainable use of all forms of renewable energy. The Global Atlas for Renewable Energy (Global Atlas) is an initiative coordinated by IRENA, aimed at closing the gap between nations having access to the necessary datasets, expertise and financial support to evaluate their national renewable energy potential, and those countries lacking such elements.

As of January 2015, 67 countries and more than 50 institutes and partners were contributing to the initiative.

The Global Atlas facilitates a first screening for areas of opportunity where further assessments can be of particular relevance. It enables the user to overlay information listed in a catalogue of more than 1,000 datasets, and to identify areas of interest for further prospection.

This brochure presents an extract of the datasets hosted by the Global Atlas. All information published in this booklet is available through the Global Atlas interface. IRENA is continuously adding information to the system.

Currently, the initiative includes maps on solar, wind, geothermal and bioenergy resources along with one marine energy map. The initiative will eventually encompass all renewable energy resources, providing global coverage through the first-ever Global Atlas for Renewable Energy.

IRENA wishes to thank the data providers of the Global Atlas for making this publication possible.

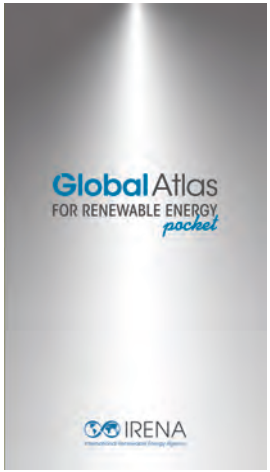
Access the Global Atlas for Renewable Energy: http://irena.org/globalatlas

Contents

Geothermal section:

Contents

RENEWABLES WITHOUT BORDERS



GLOBAL ATLAS POCKET: AVAILABLE JANUARY 2015

PUSHING THE BOUNDARIES OF KNOWLEDGE

RESOURCE

YOUR SOURCE FOR RENEWABLE ENERGY INFORMATION

WWW.IRENA.ORG/RESOURCE

THE GLOBAL ATLAS INTERFACE IN A NUTSHELL

The Global Atlas is a prospector for renewable energy opportunities.

The online Geographic Information System (GIS) enables users to visualise renewable energy resource maps, and to overlay additional information on, for example, protected areas, roads or infrastructure. The platform allows users to create and save thematic maps. The Atlas interface integrates software and tools that allow advanced energy or economic calculations for evaluating the technical and economic potential for renewable energy development.

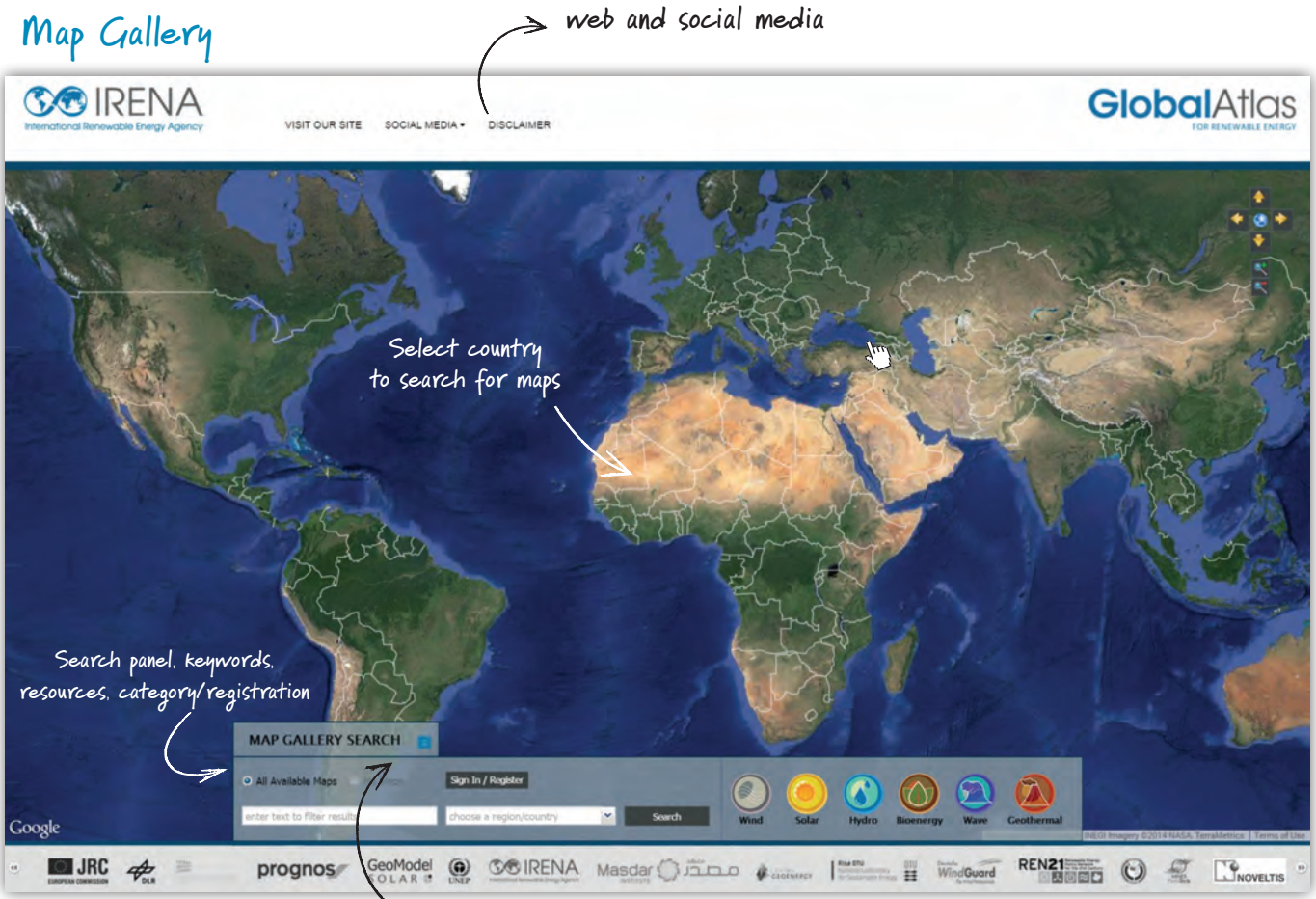
irena.org/globalatlas

Global Atlas 2.0

New functionalities:

- Map gallery: Search maps by keyword, country, resource
- Infopicker: Access country profiles from REsource
- Universal data viewer: Solar and wind graphs and charts in one click

Map Gallery


web and social media
IRENA
International Renewable Energy Agency
VISIT OUR SITE
SOCIAL MEDIA
DISCLAIMER
GlobalAtlas
FOR RENEWABLE ENERGY
Select country
to search for maps
Search panel, keywords,
resources, category/registration
MAP GALLERY SEARCH
All Available Maps
Sign In / Register
enter text to filter results
choose a region/country
Search
Wind
Solar
Hydro
Bioenergy
Wave
Geothermal
Google
MAP GALLERY

THE GLOBAL ATLAS INTERFACE IN A NUTSHELL

Map interface

User interface: Visualises GIS-based information, such as renewable energy resources, infrastructure, population, protected areas. The interface loads layers from a catalogue of more than 1,000 datasets.

Layer: A file containing geographic information (map or map features) displayed through a GIS interface. Several layers can be superposed.

Map: Sum of activated layers. A map can be saved under the user's profile.

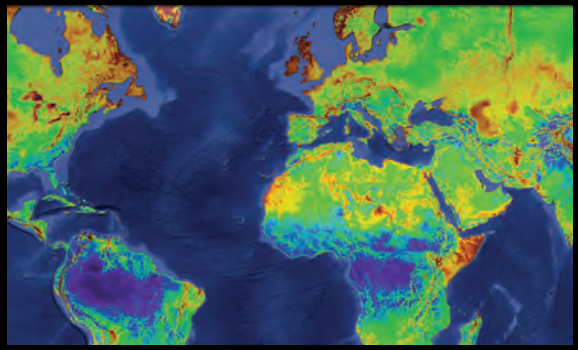
Legend and tools: Displayed for each individual layer. Online tools are available to perform analysis in real time.

Menu bar:

- map gallery
- create and edit map
- search for data and all layers
- share your map
- save your map

User interface

A Global Atlas map: the sum of activated layers



3TIER

Geographic coverage: Global
Source: 3TIER

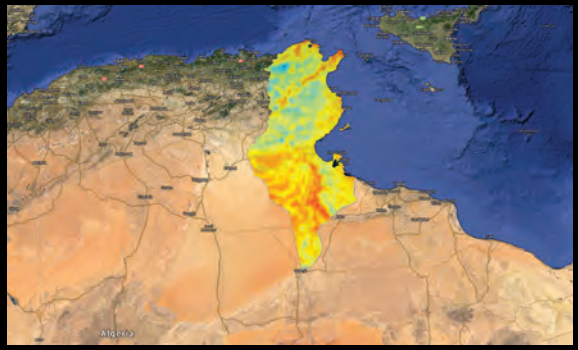
Website: www.3TIER.com
Direct access: http://irena.masdar.ac.ae/?map=543

Description: The Global Solar dataset compiles more than 11 years of data and was compared to 92 surface stations across the globe. The spatial resolution is 3 km. The Global Wind Dataset provides the average annual wind speed at 80 m. It is built from computer simulations of hourly values over a 10-year period. The wind speeds were compared to observations from more than 4,000 meteorological stations around the globe from the National Centers for Environmental Prediction (NCEP) Automated Data Processing dataset, with a spatial resolution of approximately 5 km.

Detailed description: www.3tier.com/static/ttcms/us/documents/publications/validations/3TIER_Global_Solar_Validation.pdf

Original website: www.3tier.com/en/about/publications/firstlook-global-wind-dataset-annual-mean-validation/

Agence Nationale pour la Maitrise de l'Energie (ANME)



Geographic coverage: Tunisia
Source: Agence Nationale pour la Maîtrise de l'Energie (National Agency for Energy Management)

Website: www.anme.nat.tn
Direct access: http://irena.masdar.ac.ae/?map=488

Description: The project was financed by the Spanish Agency of International Cooperation for Development (AECID) and the Government of Navarra in collaboration with the Government of Tunisia through the National Agency for Energy Management (ANME). Wind maps are generated in GIS format at 1 km x 1 km resolution at different heights: 10 m, 60 m, 80 m and 100 m.

Australian Bureau of Meteorology (BOM)

Geographic coverage: Australia
Source: Australian Bureau of Meteorology

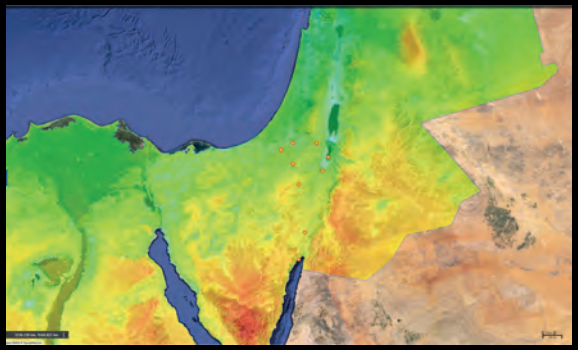
Website: www.bom.gov.au
Direct access: http://irena.masdar.ac.ae/?map=406

Description: Global solar exposure is the total amount of solar energy falling on a horizontal surface over a specified period. These monthly, seasonal and annual average daily datasets are based on 22 years of solar exposure data (1990-2011), derived from the Japan Meteorological Agency and the Australian National Oceanographic and Atmospheric Administration satellite imagery, using a physical model developed by the Australian Bureau of Meteorology.

Detailed description:
www.bom.gov.au/climate/averages/climatology/gridded-data-info/metadata/md_ave_sol_exp.shtml

Original website:
www.bom.gov.au/jsp/awap/solar/index.jsp

Ben-Gurion University of the Negev



Geographic coverage: Israel
Source: Ben-Gurion University of the Negev

Website: http://in.bgu.ac.il/en/Pages/default.aspx
Direct access: http://irena.masdar.ac.ae/?map=977

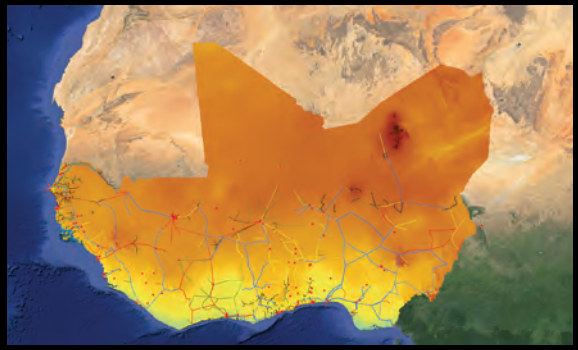
Description: This dataset contains the annual average solar radiation from nine stations in Israel. A 20-year database of meteorological measurements from the Negev sites: Arad, Beersheba, Besor Farm, Eilat, Hatzeva, Mitzpe Ramon, Sede Boqer, Sedom and Yotvata was employed to synthesise a set of updated Typical Meteorological Year data files (TMY v.5) based on the direct beam component, and the archived hourly data.

Detailed Description:

http://irena.masdar.ac.ae/docs/Israel_solar_radiation_maps_of_the_Negev.pdf

http://irena.masdar.ac.ae/docs/Israel_data_processing_for_the_Negev_radiation_survey.pdf

ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE)



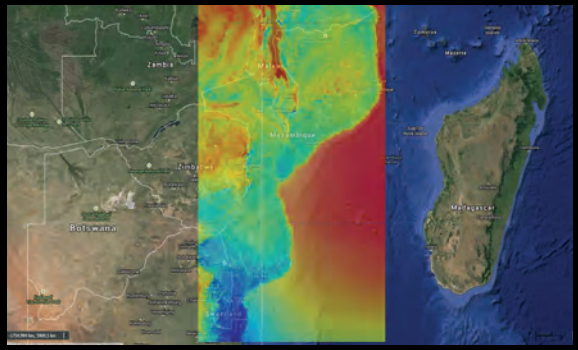
Geographic coverage: The Economic Community of West African States (ECOWAS)
Source: ECOWAS Center for Renewable Energy and Energy Efficiency

Website: www.ecreee.org
Direct access: Search 'ECREEE' through the Global Atlas Data Browser.

Description: The ECOWAS Observatory for Renewable Energy and Energy Efficiency (ECOWREX) provides decision makers, project developers, investors and other stakeholders, with tailored information and decision support tools. The project was implemented by ECREEE and United Nations Industrial Development Orgnaization (UNIDO). It is financed by the Global Environment Fund (GEF) with support from the Austrian Development Cooperation (ADC), the Spanish Agency for International Development Cooperation (AECID) and the U.S. Agency for International Development (USAID).

Detailed description and original website:
www.ecowrex.org

Eduardo Mondlane University



Geographic coverage: Mozambique
Source: MINES ParisTech

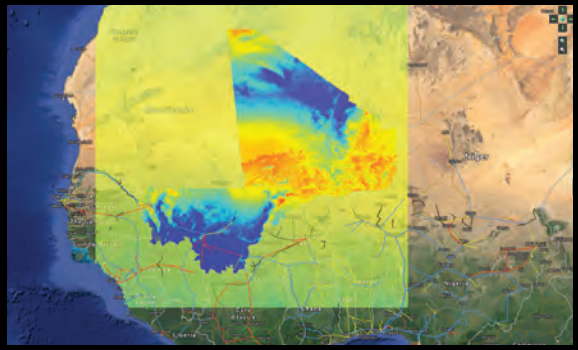
Website: www.oie.mines-paristech.fr
Direct access: http://irena.masdar.ac.ae/?map=1153

Description: Maps of yearly and monthly means of daily surface solar irradiation, or daily solar exposure in Mozambique, for global, direct and diffuse irradiation received on horizontal plane and direct irradiation received on a mobile plane always facing the sun. Copyright 2014 MINES ParisTech, University Eduardo Mondlane, Mozambique Meteorological Institute.

The maps compile ten years (2004-2013) of daily irradiation provided by the HelioClim-3 database built from proper processing of satellite images by MINES ParisTech and its associated company Transvalor.
The project was financed by the French Ministry for Foreign Affairs (MAEE) and was undertaken by a research group composed of MINES ParisTech of France, University Eduardo Mondlane and National Meteorological Institute of Mozambique, and Masdar Institute of Abu Dhabi.

Detailed description and original website:
www.soda-pro.com

Feasibility of Renewable Energy Resources in Mali (FRSE)



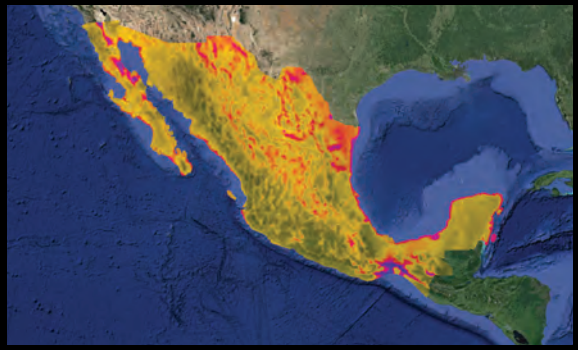
Geographic coverage: Mali
Source: Feasibility of Renewable Energy Resources in Mali

Website: http://frsemali.org
Direct access: http://irena.masdar.ac.ae/?map=416

Description: The objective of the project is to provide basic planning information for enhanced use of sustainable energy in Mali. The project is carried out by a group of university departments, research institutions and consultants led by the UNEP Risø Centre (URC) at the Technical University of Denmark (DTU) and conducted in cooperation with Direction Nationale de l'Energie (DNE) and Centre National de l'Energie Solaire et des Energies Renouvelables (CNESOLER) in Mali.

Detailed description:
http://frsemali.org/research_papers.htm

Institutos de Investigaciones Electricas (IIE)



Geographic coverage: Mexico
Source: Institutos de Investigationes Electricas (IIE) and Secretary of Energy (SENER)

Website: http://sag01.iie.org.mx/eolicosolar/
Direct access: http://irena.masdar.ac.ae/?map=619

Description: Preliminary wind resource maps for Mexico were made by using hourly wind speed data for the year 2005, obtained by means of the MM5 program at 50 m height every 9 km.

Extrapolation of wind speed at 80 m was performed by using the power law with an exponent of one-seventh. Subsequently, the velocity values obtained every 9 km were interpolated each 1 km.

The wind resource maps are available on the IIE's website at 50 m and 80 m height on a monthly and annual basis, for wind speed and power density.

Detailed description:
http://sag01.iie.org.mx/metadatos.htm

Joint Research Center (JRC) — European Commission

Geographic coverage: Africa
Source: European Commission Joint Research Center

Website: www.euei.net/wg/african-renewable-energy-technology-platform-afretep
Direct access: http://irena.masdar.ac.ae/?map=525

Description: Solar photovoltaic (PV) analyses for Africa by the European Commission Joint Research Center:

- Modelled most economic rural electrification option (off-grid PV system, grid extension, mini-hydro, diesel generator).
- Comparison between estimated PV and diesel minigrid costs in euros per kilowatt-hour (EUR/kWh).
- Estimated costs of electricity (EUR/kWh) delivered by a 15 kilowatt-peak off-grid PV system.
- Estimated costs of electricity (EUR/kWh) delivered by a diesel generator using the diesel price for each country and taking into account the cost of diesel transportation.

Detailed description: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/23076/1/reqno_jrc67752_final%20report%20.pdf

King Abdullah City for Atomic and Renewable Energy (K.A.CARE)

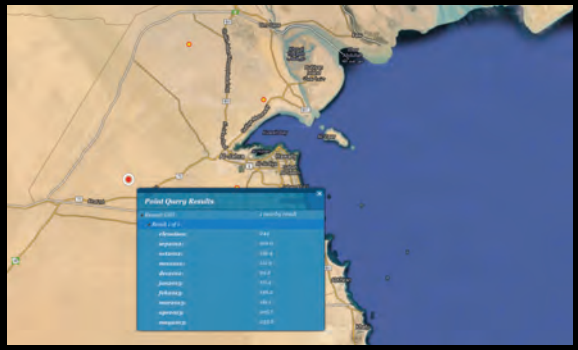
Geographic coverage: Saudi Arabia
Source: King Abdullah City for Atomic and Renewable Energy (K.A.CARE)

Website: https://rratlas.kacare.gov.sa/RRMMPublicPortal/
Direct access: http://irena.masdar.ac.ae/?map=852

Description: KA CARE's Renewable Resource Monitoring and Mapping (RRMM) programme focuses on monitoring and mapping the renewable energy resources in the Kingdom. The RRMM Programme also includes the operation, calibration, and maintenance, of a newly deployed solar resource monitoring network, and collaboration for the development of a wind resource monitoring programme throughout the Kingdom. Waste-to-energy and geothermal resources will receive increased attention in the Atlas as the RRMM Programme expands. The Programme will support the mission of KA CARE towards a target of renewable energy supplying 50% of the Kingdom's energy needs by 2032.

Detailed description: www.kacare.gov.sa/

Kuwait Institute for Scientific Research (KISR)

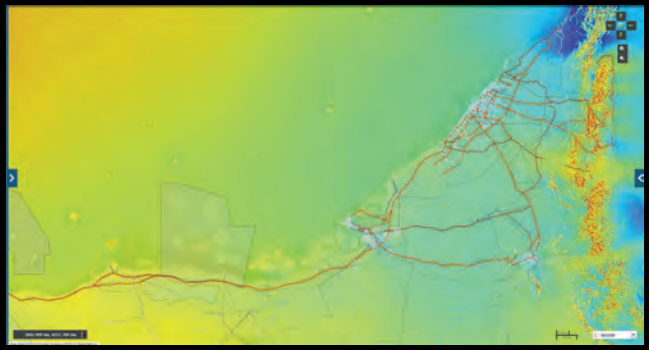


Geographic coverage: Kuwait
Source: Kuwait Institute for Scientific Research

Website: www.kisr.edu.kw/
Direct access: http://irena.masdar.ac.ae/?map=585

Description: Monthly average values for five measurement stations in Kuwait for solar and wind parameters, humidity, and temperature. Measurements cover the period September 2012 – August 2013.

Detailed description: N/A



Masdar Institute

Geographic coverage: United Arab Emirates
Source: Masdar Institute of Science and Technology

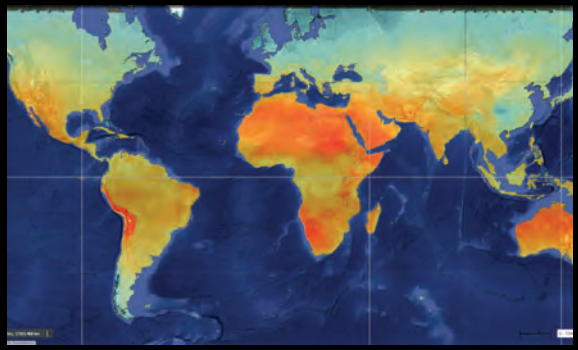
Website: recrema.masdar.ac.ae
Direct access: http://irena.masdar.ac.ae/?map=401; http://irena.masdar.ac.ae/?map=1076

Description: The UAE solar atlas makes solar resource maps easily available to end-users and stakeholders. The portal shows solar atlas maps over a base map and provides basic data management tools, including the possibility to access pixel values and to derive histograms of solar resources.

The UAE wind atlas makes wind resource maps easily available to end-users and stakeholders. The portal shows wind atlas maps over a base map and provides basic data management tools, including the possibility to access pixel values and to derive wind roses and histograms of wind resources.

Detailed description:
http://solaratlas.masdar.ac.ae/

http://windatlas.masdar.ac.ae/



Meteotest

Geographic coverage: Global
Source: Meteotest

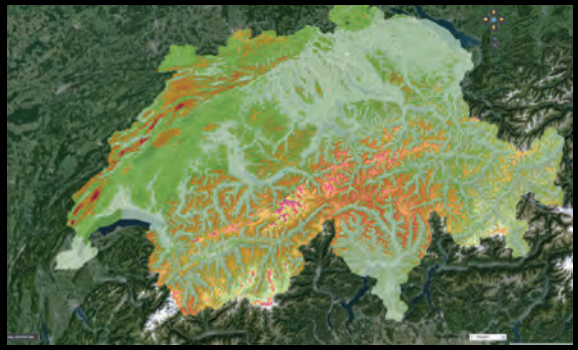
Website: www.meteotest.ch/en/
Direct access: http://irena.masdar.ac.ae/?map=871

Description: Global horizontal irradiation (GHI) (kWh/m^2) with 8 km resolution. © METEOTEST.
Meteonorm is a comprehensive meteorological reference. It provides access to a catalogue of meteorological data for solar applications and system design at any desired location in the world.

Numerous global and regional databases have been combined and checked for their reliability. In the current version, predominantly the data is taken from GEBA (Global Energy Balance Archive), from the World Meteorological Organization (WMO/OMM) Climatological Normals 1961 – 1990 and from the Swiss database compiled by MeteoSwiss. The station data is supplemented by surface data from five geostationary satellites. All this information is available on a global grid with a horizontal resolution of 8 km (3 km in Europe and Northern Africa).

Detailed description: www.meteonorm.com

Meteotest



Geographic coverage: Switzerland
Source: Meteotest

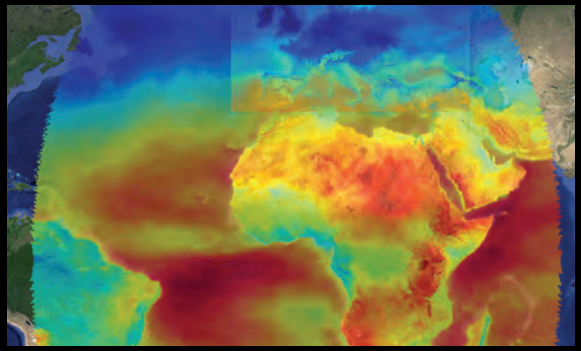
Website: www.meteotest.ch/en/
Direct access: http://irena.masdar.ac.ae/?map=982

Description: Wind speed (100 m above ground) for Switzerland (m/s), 100 m resolution; Source: www.wind-data.ch. © METEOTEST. Meteonorm is a comprehensive meteorological reference. It provides access to a catalogue of meteorological data for solar applications and system design at any desired location in the world.

Numerous global and regional databases have been combined and checked for their reliability. In the current version, predominantly the data is taken from GEBA (Global Energy Balance Archive), from the World Meteorological Organization (WMO/OMM) Climatological Normals 1961 – 1990 and from the Swiss database compiled by MeteoSwiss. The station data is supplemented by surface data from five geostationary satellites. All this information is available on a global grid with a horizontal resolution of 8 km (3 km in Europe and Northern Africa).

Detailed description: www.meteonorm.com

MINES ParisTech



Geographic coverage: Africa, Europe, Middle East, Latin America (part)
Source: MINES ParisTech

Website: www.oie.mines-paristech.fr/
Direct access: http://irena.masdar.ac.ae/?map=529

Description: The Heliosat method converts Meteosat satellite images into maps of solar radiation that are then feed into the HelioClim databases. HelioClim-1 covers the period 1985-2005. HelioClim-3 started in 2004 and is updated daily. These databases can be accessed through the SoDa Service. The SoDa Service delivers information on solar radiation (data, databases, algorithms, advanced applications). It can be accessed from the 'tools' section of the Global Atlas.

Detailed description and original website:
www.helioclim.org

Ministry of Energy and Mines

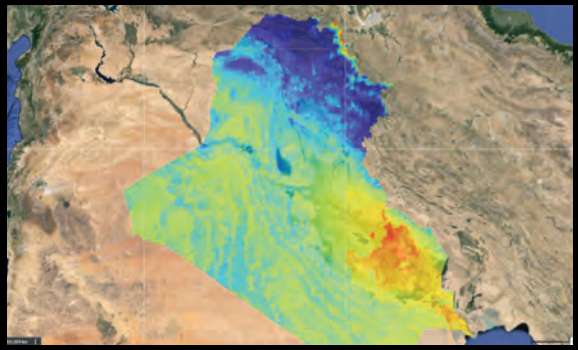
Geographic coverage: Peru
Source: Data supplied by Ministry of Energy and Mines of Peru

Website: http://dger.minem.gob.pe/
Direct access: http://irena.masdar.ac.ae/?map=1064; http://irena.masdar.ac.ae/?map=1065

Description: The solar atlas of Peru shows the annual and monthly average global horizontal solar irradiation (GHI) incident in Peru, calculated over a period from 1975 – 1990, and presented at a scale of 1:100,000.
The irradiation data were obtained by processing heliophany and temperature data from a compressive database. In total, records from 197 stations nationwide were used.
The Wind Energy Atlas of Peru shows annual and seasonal average wind speeds at 50 m, 80 m and 100 m heights.
The map has been calculated using mesoscale and microscale modelling, combined with the use of a sophisticated simulation model reproducing atmospheric wind patterns on a large scale.

Original website:
Solar atlas: http://dger.minem.gob.pe/atlassolar/
Wind atlas: http://dger.minem.gob.pe/atlaseolico/PeruViento.html

Ministry of Science and Technology



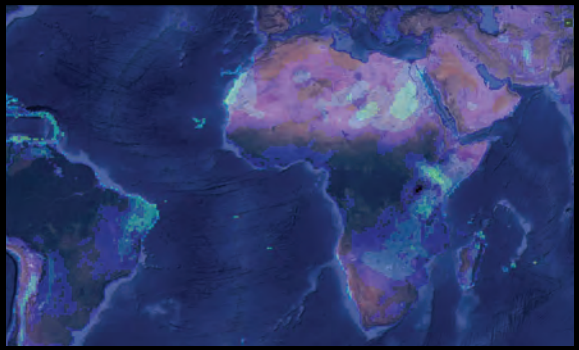
Geographic coverage: Iraq
Source: National Renewable Energy Center (CENER)

Website: None
Direct access: http://irena.masdar.ac.ae/?map=876

Description: Maps available for wind density, Weibull A and Weibull k at 30 m, 50 m, 100 m height, with 5 km resolution. The maps were calculated by the Spanish Center for Renewable energy (CENER) for the Iraq Ministry of Science. The period simulated is since June 2003 until June 2012.

The maps are calculated by simulating atmospheric conditions with the SKIRON mesoscale model, using as input the GFS 12 UTC cycle from NCAR/NCEP. SKIRON's long-term simulation spans nine-year, generating hourly maps for the entire period. This output allows an Iraqi wind map to be computed, averaging 100 m for Weibull Parameter A over the simulated period. Typically, the horizontal grid resolution is 0.05^{o} x 0.05^{o} and has 50 vertical levels.

National Aeronautics and Space Administration (NASA)

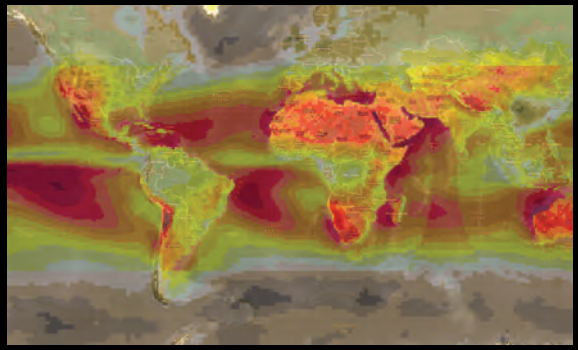


Geographic coverage: Global
Source: National Aeronautics and Space Administration

Website: www.nasa.gov
Direct access: http://irena.masdar.ac.ae/?map=399

Description: Modern-Era Retrospective Analysis for Research and Applications (MERRA) is a NASA reanalysis for the satellite era using a major new version of the Goddard Earth Observing System Data Assimilation System Version 5 (GEOS-5). The Project focuses on historical analyses of the hydrological cycle on a broad range of weather and climate time scales and places the NASA Earth Observing System (EOS) suite of observations in a climate context.

Detailed description and original website:
http://gmao.gsfc.nasa.gov/merra/



NASA

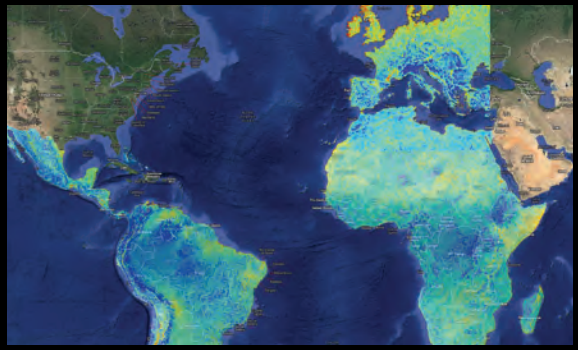
Geographic coverage: Global
Source: National Aeronautics and Space Administration

Website: www.nasa.gov
Direct access: http://irena.masdar.ac.ae/?map=178

Description: The Surface meteorology and Solar Energy (SSE) project is developing the commercial potential of NASA's cloud, radiation, and meteorology data by working closely with partners from government, commercial industry, educational, and non-profit organisations.

Detailed description: https://eosweb.larc.nasa.gov/sse/
Original website: http://en.openei.org/appsSWERA/

National Renewable Energy Center (CENER)



Geographic coverage: Latin America, Europe, Africa, Spain, Tunisia, Iraq
Source: Centro National de Energias Renovables (National Renewable Energy Center — Spain)

Website: www.cener.com
Direct access: http://irena.masdar.ac.ae/?map=422

Description: The atmospheric conditions are modelled using the SKIRON mesoscale model. The SKIRON long-term simulation spans at least a three-year period, generating hourly maps to simulate the whole domain. This methodology has been successfully validated with measurements spread over four continents.

Detailed description:
http://secure.cener.com/documentos/wind-resources-map-mesoscale-PaperEwec08.pdf

Offshore wind projects

Geographic coverage: Belgium offshore
Source: Data supplied by the Belgium Ministry of Economy

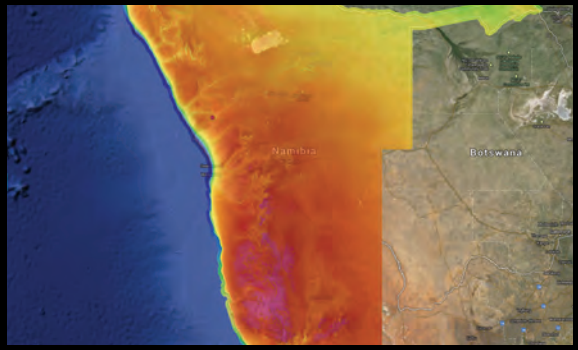
Website: www.mumm.ac.be/EN/Management/Sea-based/windmills.php
Direct access: http://irena.masdar.ac.ae/?map=603

Description: The Global Atlas displays the bathymetry, offshore wind energy clusters and project locations for Belgium.

Detailed description: All information for offshore wind farms in Belgium are available at www.mumm.ac.be/EN/Management/Sea-based/windmills.php

Definition of the concession zones (available in French (FR) and Dutch (NL): www.creg.be/fr/greenelec1.html

Renewable Energy and Energy Efficiency Institute (REEEI)



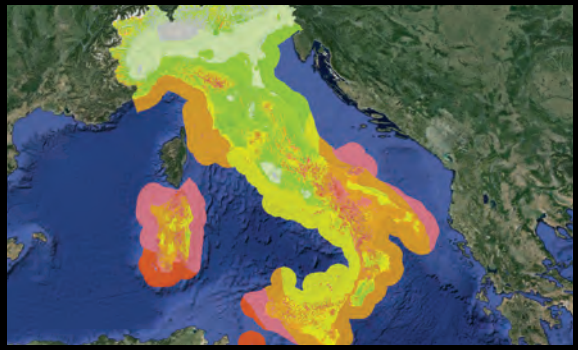
Geographic coverage: Namibia
Source: Renewable Energy and Energy Efficiency Institute

Website: www.reeei.org.na
Direct access: http://irena.masdar.ac.ae/?map=178

Description: Direct normal irradiation values. Annual and monthly long-term average, representing years 1994-2011. © 2012 GeoModel

Detailed description and original website:
http://solargis.info

Ricerca sul Sistema Energetico (RSE)



Geographic coverage: Italy
Source: RSE S.p.A.

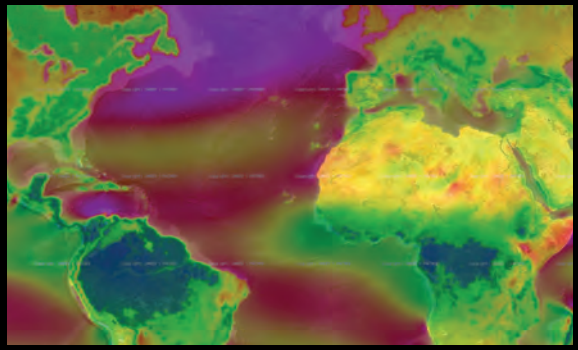
Website: http://atlanteeolico.rse-web.it
Direct access: http://irena.masdar.ac.ae/?map=617

Description: Annual mean wind speed and other specific maps at four levels (25 m 50 m 75 m and 100 m) above ground and above sea, with 1 km spatial resolution, are available in a WebGIS for navigation and free download.

The maps have been calculated by means of Genoa University's WINDS model. The onshore maps have been calibrated using data from more than 200 stations, whereas the offshore maps were calibrated with satellite data and the few direct measurements available.

Constraint maps can be overlapped. A performance calculation tool allows the user to perform a technicaly-economical evaluation of theoretical wind farms based on the dataset of the Wind Atlas.

Detailed description: http://doc.rse-web.it/doc/doc-sfoglia/12003699-315158/12003699-315158.html



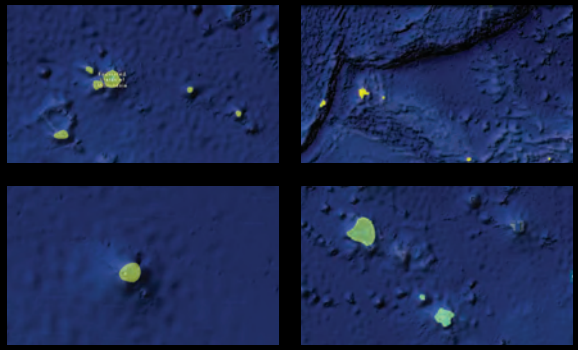
Sander + Partner

Geographic coverage: Global
Source: Sander + Partner

Website: www.sander-partner.com
Direct access: http://irena.masdar.ac.ae/?map=180

Description: Mean wind speed at 50 m above ground estimated for the period 1980 - 2011. The mean wind speed is based on values for each hour during this 32-year period. Wind speeds change from one year to another. The maps only show the potentials, while the financial risks of volatile winds remain unexplored. A wind index shows the change of wind speed from one year to the next. Register for free at www.sander-partner.com and view the local wind index for any location in the World.

Primary source of the data: NASA.
Primary citation: Rienecker, *et al.* (2011), MERRA - NASAs Modern-Era Retrospective Analysis for Research and Applications. *Journal of Climate*, Vol. 24, pp. 3624-3648.



Secretariat of the Pacific Community (SPC)

Geographic coverage: North Pacific region
Source: Secretariat of the Pacific Community

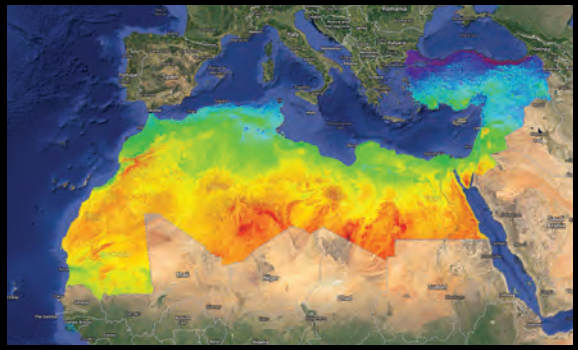
Website: www.spc.int
Direct access:

- Chuuk: http://irena.masdar.ac.ae/?map=447
- Pohnpei: http://irena.masdar.ac.ae/?map=491
- Yap: http://irena.masdar.ac.ae/?map=492
- Kosrae: http://irena.masdar.ac.ae/?map=493

Description: The North Pacific ACP (African, Caribbean and Pacific) Renewable Energy and Energy Efficiency Project (North-REP) is a unique project aimed at developing the energy sectors of the Federated States of Micronesia, the Republic of the Marshall Islands and Palau. These three SPC members have pooled the combined EUR 14.4 million from the 10th European Development Fund and entrusted SPC to manage the project. This highlights the special partnership between a provider of technical assistance and services, and its recipient member countries and territories. It also highlights the collaboration and vision in working together to improve the livelihoods of residents living in the north Pacific region.

Detailed description: www.spc.int/edd/fr/section-01/energy-overview/energy/77-north-pacific-acp-renewable-energy-and-energy-efficiency-project-north-rep

Solar Atlas for the Mediterranean



Geographic coverage: Mediterranean area.
Source: Solar-Med Atlas

Website: www.solar-med-atlas.org
Direct access: http://irena.masdar.ac.ae/?map=178

Description: The project brings high resolution (1 km), long term coverage (20 years: 1991 - 2010) data for the whole target region. The resource data is derived from Earth Observation satellite data, based on published and transparent methodologies, and has been validated with existing ground measurements in the region.
The database is provided by SOLEMI and Helioclim-3 (SoDa).

Detailed description:
www.solar-med-atlas.org/solarmed-atlas/about.htm

South Africa Wind Atlas (WASA)

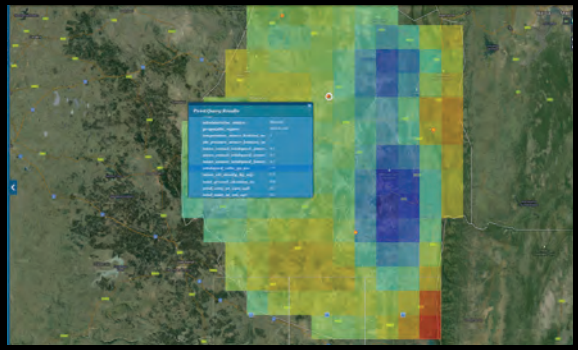
Geographic coverage: South Africa
Source: South African National Energy Development Institute

Website: www.wasaproject.info
Direct access: http://irena.masdar.ac.ae/?map=405

Description: The Wind Atlas for South Africa (WASA) is an initiative of the South African Department of Energy (DoE), with the South African National Energy Development Institute (SANEDI) executing and managing WASA, and contracting the Implementation Partners (Council for Scientific and Industrial Research, South African Weather Service, University of Cape Town — Climate Systems Analysis Group, and the Technical University of Denmark — Wind Energy). WASA's main objective, through capacity development and research cooperation, is to develop and employ numerical (modelled) wind atlas methods, as well as develop capacity to enable long term planning of large-scale exploitation of wind power in South Africa. This will include dedicated wind resource assessments and siting tools for planning purposes, *i.e.*, verified with physical wind measurements numerical (modelled) Wind Atlas, Extreme Wind Atlas, high resolution Wind Resource map and database for South Africa.

Detailed description:
www.wasaproject.info/about_wind_energy.html

Swaziland National Energy Policy Development Project

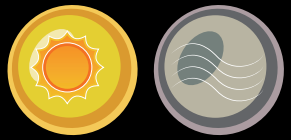


Geographic coverage: Swaziland
Source: Swaziland National Energy Policy Development Project

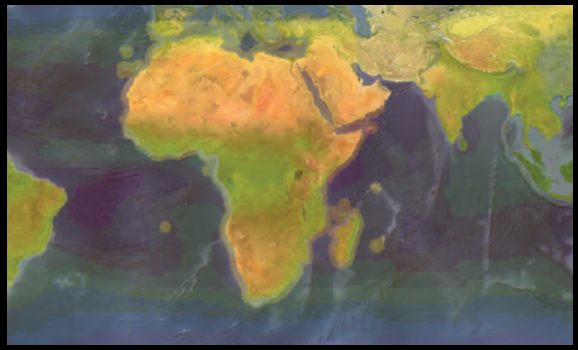
Website: None
Direct access: http://irena.masdar.ac.ae/?map=299

Description: Wind measurements were taken from five measurement stations in Swaziland. The data was collected between May 2001 and April 2002 under the wind measurement project, which was part of the Swaziland National Energy Policy Development Project and supported by the Danish Co-operation for Environment and Development (DANCED).

Detailed description: http://irena.masdar.ac.ae/docs/Wind_Measurements_in_Swaziland_Final.pdf



United Nations Environment Programme (UNEP)



Geographic coverage: Global
Source: UNEP, Solar and Wind Resource Assessment (SWERA)

Website: http://en.openei.org/apps/SWERA/
Direct access: Search 'SWERA' through the Global Atlas Data Browser to access the data archive.

Description: The Solar and Wind Energy Resource Assessment (SWERA) began in 2001 to advance the large-scale use of renewable energy technologies, by increasing the availability and accessibility of high quality solar and wind resource information. SWERA began as a pilot project with funding from the Global Environment Facility (GEF) and managed by the United Nations Environment Programme's (UNEP) Division of Technology, Industry and Economics (DTIE) in collaboration with more than 25 partners around the world. With the success of the project in 13 pilot countries, SWERA expanded in 2006 into a full programme.

SWERA provides high quality information on renewable energy resources for countries and regions around the world, together with the tools to utilise the data and facilitate renewable energy policies and investments.

Detailed description: http://en.openei.org/wiki/SWERA/About

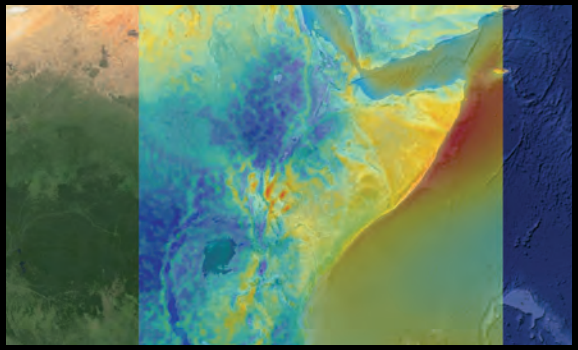
University of Zimbabwe

Geographic coverage: Zimbabwe
Source: T. Hove, E. Manyumbu and G. Rukweza (2014), "Developing an improved global solar radiation map for Zimbabwe through correlating long-term ground- and satellite-based monthly clearness index values" *Renewable Energy*, Vol. 63, pp. 687-697.

Website: None
Direct access: http://irena.masdar.ac.ae/?map=620

Description: Global solar radiation map for Zimbabwe obtained through correlating long-term ground- and satellite-based monthly clearness index values.

Detailed description: http://irena.masdar.ac.ae/docs/Solar_radiation_map_Zimbabwe_T_Hove_E_Manyumbu_G_Rukweza.pdf



Vortex

Geographic coverage: Sample on East Africa
Source: Vortex

Website: www.vortex.es
Direct access: http://irena.masdar.ac.ae/?map=180

Description: Data collected between the years 1992 and 2011, at 80 m high, gives mean wind speeds, as generated by Vortex based on NCEP reanalysis data and downscaled using the Weather Research and Forecasting model (WRF), providing up to 9 km resolution for pre-screening qualitative assessment purposes only.

The data forms the basis for Vortex commercial products of 3 km resolution, validated for the temporal variability, and 100 km resolution for site-scale values.

Detailed description: www.wrf-model.org

Canadian Geothermal Energy Association (CanGEA)

Geographic coverage: Alberta, Canada
Source: Canadian Geothermal Energy Association

Website: www.cangea.ca/
Direct access: http://irena.masdar.ac.ae/?map=690

Description: The Geothermal Favourability Map of Alberta rates parts of Alberta, Canada, based on their degree of favourability for geothermal exploration. The resulting favourability rating is based on geothermal gradients and ambient temperatures. This assessment is further linked to the temperature requirements of current technology used for exploration. The ratings are consistent with geothermal favourability mapping projects completed by Northwest Territories Environment and Natural Resources.

Detailed description: http://irena.masdar.ac.ae/docs/Geothermal_Favourability_Map_of_Alberta_following_a_Global_Protocol_Methods_and_Data_Sources.pdf

Dewhurst Group

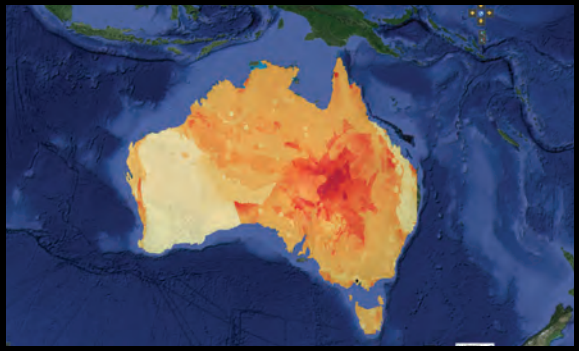
Geographic coverage: Kenya
Source: Dewhurst Group

Website: www.spangeokenya.com/
Direct access: http://irena.masdar.ac.ae/?map=700

Description: The map presents the results of an analysis for potential areas for geothermal exploration across Kenya. The analysis was performed by Dewhurst Group using the Spectral Space Analysis technique (SPAN), which models aeromagnetic data to identify potential exploration targets.

Based on the analysis, certain regions show a high probability of having temperatures of up to 400°C at a depths of 4 km to 5 km, and a sizable regional reservoir at depths of 2 km to 6 km. The priority areas are also expected to contain deep fluid connections to magma and mantel zones at around 10 km or deeper, The Dewhurst Group is currently undertaking similar geothermal exploration efforts in Uganda, Rwanda, Ethiopia and Djibouti.

Detailed description: www.spangeokenya.com/



Hot Dry Rocks

Geographic coverage: Australia
Source: Hot Dry Rocks

Website: www.hotdryrocks.com/
Direct access: http://irena.masdar.ac.ae/?map=855

Description: These maps show the average predicted temperature of Australian basement rocks at 1 km intervals between 3 km and 10 km depth. The maps are direct indicators of the potential for Enhanced Geothermal Systems (EGS) Development. A description of the methodology underpinning the maps, the datasets and assumptions that have been used is detailed in a Global Protocol for estimating and mapping global EGS potential.

Detailed description:
http://pubs.geothermal-library.org/lib/grc/1028662.pdf

Instituto para la Diversificación y Ahorro de la Energía (IDAE)

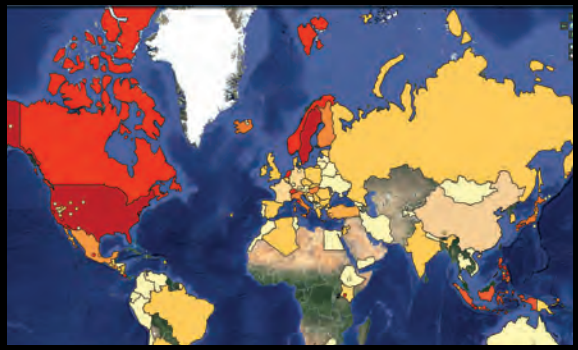
Geographic coverage: Spain
Source: Instituto para la Diversificación y Ahorro de la Energía (Institute for Diversification and Energy Saving)

Website: www.idae.es/
Direct access: http://irena.masdar.ac.ae/?map=714

Description: This map shows potential areas for geothermal energy development across the Spanish territory in gigawatts. The map presents a number of layers highlighting the accessible, available and total potential for low, medium, and high temperature resources. It also features a layer indicating the potential for enhanced geothermal systems across the country.

Detailed description:
www.idae.es/uploads/documentos/documentos_11227_e9_geotermia_A_db72b0ac.pdf

International Heat Flow Commission



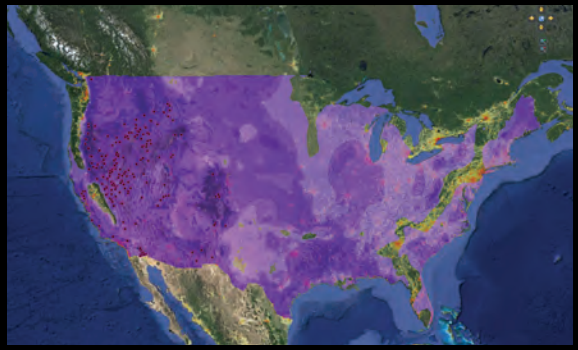
Geographic coverage: Global
Source: International Heat Flow Commission

Website: www.iaspei.org/commissions/IHFC.html
Direct access: http://irena.masdar.ac.ae/?map=688

Description: The global heat flow dataset is maintained by the International Heat Flow Commission (IHFC) of the International Association of Seismology and Physics of the Earth's Interior (IASPEI). This effort has been undertaken in collaboration with University of North Dakota. This is a new global compilation consisting of 35,523 continental heat flow points and 23,013 marine points. Last updated January 2011.

Original website:
www.heatflow.und.edu/index2.html

National Renewable Energy Laboratory (NREL)



Geographic coverage: United States
Source: Southern Methodist University (SMU) and NREL

Website: http://maps.nrel.gov/gt_prospector
Direct access: http://irena.masdar.ac.ae/?map=691

Description: The map showcases hydrothermal sites identified in the United States. It also presents information on prospective areas for deep enhanced geothermal systems across the country.

Detailed Description:
http://maps.nrel.gov/gt_prospector

National Research Council (CNR)

Geographic coverage: Italy
Source: Consiglio Nazionale delle Ricerche (National Research Council)

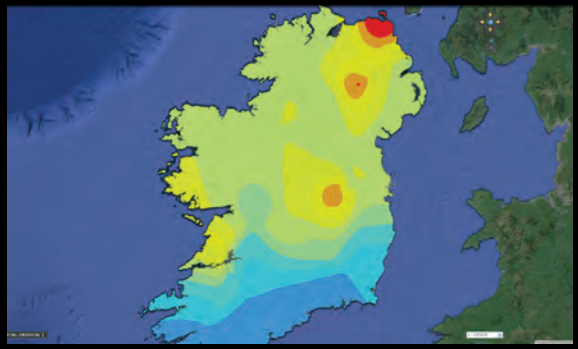
Website: http://geothopica.igg.cnr.it
Direct access: http://irena.masdar.ac.ae/?map=906

Description: The map shows the surface heat flow and temperature at depth for Italy. The temperature map at 3 km depth has been obtained through digitising the map from the scientific paper:

R. Cataldi, F. Mongelli, P. Squarci, L. Taffi, G. Zito, and C. Calore (1995), "Geothermal ranking of Italian territory", *Geothermics*, Vol. 24 No. 1, pp. 115-129.

The map has been distributed by the Institute of Geosciences and Earth Resources of the National Research Council of in Italy (CNR - IGG).

Sustainable Energy Authority of Ireland (SEAI)



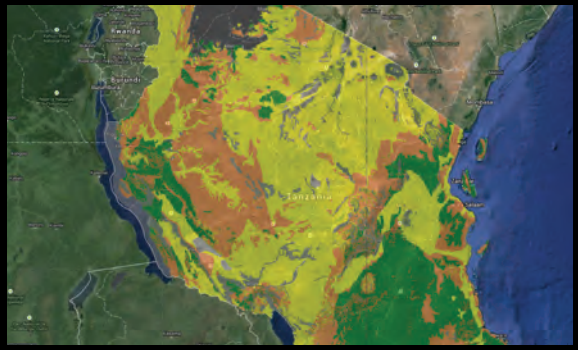
Geographic coverage: Republic of Ireland
Source: Sustainable Energy Authority of Ireland (SEAI)

Website: http://maps.seai.ie/geothermal/
Direct access: http://irena.masdar.ac.ae/?map=789

Description: The map shows the temperature profiles at 100 m, 500 m, 1,000 m, 2,500 m and 5,000 m depths, shared by the Sustainable Energy Authority of Ireland (SEAI). The map is a result of a study conducted by a consortium which involved: the CSA Group in cooperation with Conodate Geology, Cork Institute of Technology and the Geological Survey of Ireland. In this study, the consortium surveyed and compiled data on warm springs, groundwater temperature trends and available bore holes in the Republic of Ireland. Temperature data from 19 mineral and oil exploration holes ranging in depth from 300 m to 2,500 m were retrieved from previously monitored boreholes. In addition, 32 existing open boreholes with depths ranging from 40 m - 810 m, were also logged to obtain temperature profiles.

Detailed description: www.seai.ie/Renewables/Geothermal_Energy/Geothermal_Maps/

Food and Agriculture Organization (FAO)



Geographic coverage: Tanzania (United Republic of)
Source: Food and Agricultural Organization of the United Nations (FAO)

Website: www.fao.org/docrep/012/i1544e/i1544e00.htm
Direct access: http://irena.masdar.ac.ae/?map=352

Description: The maps presented in this Atlas should account for findings the original report: FAO (2010), *Bioenergy and Food Security: The BEFS Analysis for Tanzania*, (Eds.) I. Maltsoglou and Y. Khwaja, FAO, Rome. The Bioenergy and Food Security (BEFS) approach supports countries in developing evidence-based policies derived from country level information and cross institutional dialogue involving relevant stakeholders. The evidence collected is the result of technical analysis that assesses the interplay between natural resource availability, bioenergy production potential, rural development and food security. During this process the risks and opportunities are identified and the tradeoffs are defined thus supporting policy makers in the decision-making process.

Detailed Description: www.fao.org/energy/befs/en/

Global Agro-Ecological Zone (GAEZ)

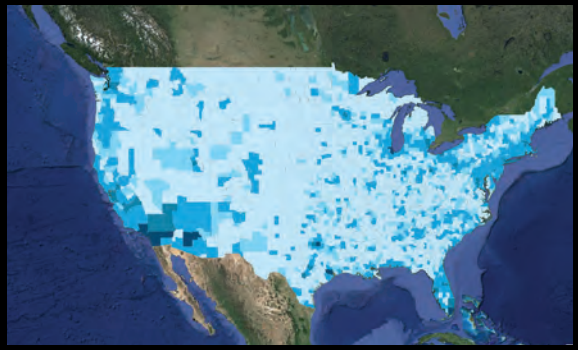
Geographic coverage: Global
Source: Food and Agricultural Organization of the United Nations (FAO), International Institute for Applied Systems Analysis (IIASA)

Website: http://webarchive.iiasa.ac.at/Research/LUC/GAEZ/index.htm
Direct access: http://irena.masdar.ac.ae/?map=1010; http://irena.masdar.ac.ae/?map=1019

Description: The Food and Agriculture Organization of the United Nations (FAO) in collaboration with the International Institute for Applied Systems Analysis (IIASA), has developed a system that enables rational land-use planning on the basis of an inventory of land resources and evaluation of biophysical limitations and potentials. This is referred to as the Agro-ecological Zones (AEZ) methodology.
This map of global land suitability shows the suitability level of a specific crop for each grid cell of the map. The land suitability is provided for the main bioenergy crops and is generated using Global Agro-Ecological Zoning (GAEZ) layers on land suitability and productivity, (FAO, IIASA, 2012).

Detailed description: www.gaez.iiasa.ac.at

National Renewable Energy Laboratory (NREL)



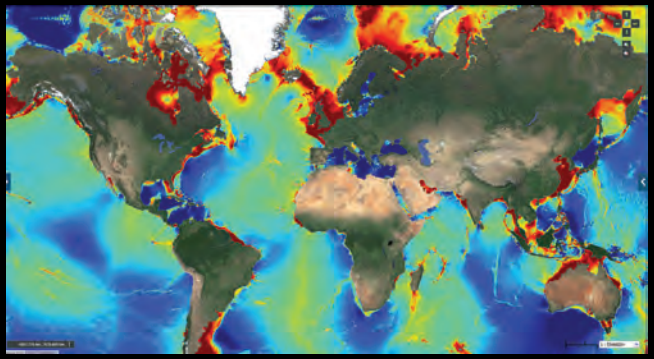
Geographic coverage: United States
Source: Biofuel Atlas of the United States

Website: http://maps.nrel.gov/biomass
Direct access: http://irena.masdar.ac.ae/?map=351

Description: Data from US Department of Agriculture National Agricultural Statistics Service and the 2011 Billion Ton Update from the US Department of Energy.

Detailed Description:
www.nass.usda.gov

www.energy.gov/eere/bioenergy/bioenergy-technologies-office



NOVELTIS

Geographic coverage: Global
Source: NOVELTIS

Website: http://tips.noveltis.com
Direct access: http://irena.masdar.ac.ae/?map=878

Description: The Global Tidal Current Atlas provides average and time series of tidal velocity. The dataset includes long-term time series for tidal elevation and velocity, and tidal information such as current direction, maximum velocity and power density.

Detailed description:
http://tips.noveltis.com/tips-metadata.html

AICD - Africa grid map 2008

The Africa Infrastructure Country Diagnostic (AICD) in 2008 produced a grid map. The database is hosted by the African Development Bank.

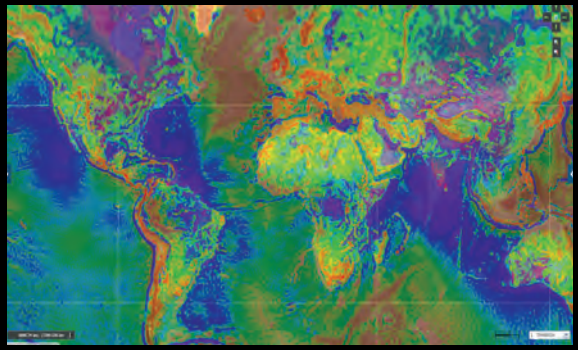
More: www.infrastructureafrica.org

Global road network

The Global Roads Inventory Project (GRIP) database is developed by the Netherlands Environmental Assessment Agency (PBL). The GRIP database was created in order to provide a current, consistent and harmonised global roads database. The data was collected from about 60 public sources (United Nations, national spatial data infrastructures (NSDIs), topographic agencies, NGOs, OpenStreetmap, etc.).

More: http://geoservice.pbl.nl/website/flexviewer/index.html?config=cfg/PBL_GRIP.xml

ESA GOCE Bouguer gravity anomaly map and free air-gravity disturbance map



GOCE free air-gravity disturbance: Derived from averaging a full set of different observations of the satellite GOCE. The gravity disturbance field is obtained by subtracting the field of an ellipsoidal homogeneous Earth model with mass equal to the mass of the real Earth (GRS80 reference field). This field reflects mostly superficial density variations in the Earth's crust.

More: www.esa.int/Our_Activities/Observing_the_Earth/GOCE

GOCE Bouguer anomaly: This field differs from the GOCE free air disturbance by subtracting the effect of global elevated land masses and the effect of ocean basins filled with water. This field reflects to a great deal the thickness variations of the uppermost layer of the stratified earth, the crust. The crust has a lower average density than the underlying mantle, and therefore a thin crust produces an increased positive Bouguer anomaly. The greater amplitude of this signal masks the superficial density variations due to the geologic density variations seen in the free air-gravity disturbance.

More: www.esa.int/Our_Activities/Observing_the_Earth/GOCE

ESA Land Cover 2009

The European Space Agency's (ESA) GlobeCover is a global land cover map that has been produced in an automatic and global way, and is associated with a legend defined and documented using the UN Land Cover Classification System (LCCS).

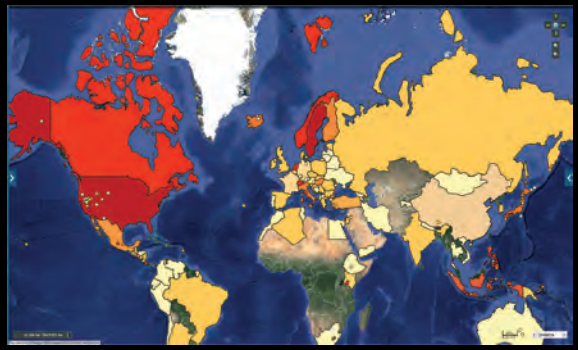
More: http://due.esrin.esa.int/globcover/

Global Land Cover 2000

Produced by the European Commission's Joint Research Center. The Global Land Cover 2000 Project (GLC 2000) provides for that year, a harmonised land cover database over the whole earth.

More: http://bioval.jrc.ec.europa.eu/products/glc2000/glc2000.php

Geothermal power installation by country, direct use and world geothermal fields



The map has been developed using the Global Geothermal Energy Database (GGED) of the International Geothermal Association (IGA).

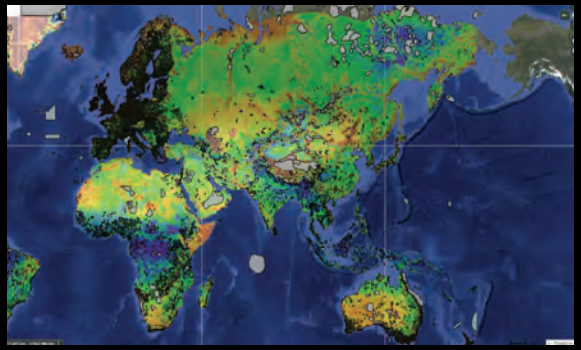
- Geothermal Installation by country: shows the total amount of installed capacity (in MWe) and produced energy per year (in MWh/y) for all the countries currently using geothermal resources for electricity generation.
- Geothermal direct use by country: shows the total amount of installed energy (in MW_{th}) and annual use (in TJh per year) for countries using geothermal heat for different uses.
- Geothermal field: shows all of the known geothermal fields across the world. For each geothermal field, the map highlights the current installed capacity (in MWe) and produced energy per year (in MWh/y).

More: www.geothermal-energy.org

Population Density 2013

Using an innovative approach with Geographic Information System and Remote Sensing, ORNL's LandScan™ is the community standard for global population distribution. At approximately 1 km resolution (30" x 30"), LandScan is the finest resolution global population distribution data available and represents an ambient population (average over 24 hours). The LandScan algorithm, an R&D 100 Award Winner, uses spatial data and imagery analysis technologies and a multi-variable asymetric modelling approach to disaggregate census counts within an administrative boundary. Since no single population distribution model can account for the differences in spatial data availability, quality, scale and accuracy, as well as the differences in cultural settlement practices, the LandScan population distribution models are tailored to match the data conditions and geographical nature of each individual country and region.

More: http://web.ornl.gov/sci/landscan/



Protected Areas 2014

The World Database on Protected Areas (WDPA) is the most comprehensive spatial dataset on the world's marine and terrestrial protected areas, produced through a joint initiative of the International Union for the Conservation of Nature (IUCN) and the United National Environment Programme (UNEP).

More: www.protectedplanet.net

Topography 2008

It provides terrain maps that show the elevation above sea level on the land, and depth of the ocean and sea bed. Data is derived from (SRTM-30) Shuttle Radar Topography Mission version 2 © 2000-2006; SRTM Mission SRTM30 plus © 2008; J.J. Becker, D.T. Sandwell, CleanTOPO2 © 2008; T. Patterson, post-processing and cartography by GeoModel Solar Resolution: 00:00:30 Terrain maps.

More: www2.jpl.nasa.gov/srtm/

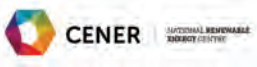
World geothermal power plants 2014

The Global Geothermal Plants database is an effort conducted by ThinkGeoEnergy to provide an inventory of the existing geothermal plants all over the world. For each geothermal plant the dataset provides the plant name, the field name, the country and region where it is located, the name plate (installed) capacity, the operator and any other relevant information.

More: www.thinkgeoenergy.com

IRENA'S PARTNERS IN THE GLOBAL ATLAS INITIATIVE


CanGEA


CENER


CLEAN ENERGY
MINISTERIAL


IGG


ECREEE


EnerGEO


ENERGY COMMISSION OF NIGERIA


ESMAP
Energy Sector Management Assistance Program


European Commission


IDAE


IGA


INSTITUTO DE
INVESTIGACIONES
ELÉCTRICAS


ISES
International
Solar Energy Society


JRC
EUROPEAN COMMISSION


MIEMDNE


MINES
ParisTech


NOVELTIS


NREL
National Renewable Energy Laboratory
Innovation for Our Energy Future


OGC
Making location count.


RCREEE


POLYTECHNIC OF NAMIBIA


reeep
renewable
energy
& energy
efficiency
partnership


reegle
information gateway
for renewable energy
and energy efficiency


REN21
Renewable Energy
Policy Network
for the 21st Century


SUSTAINABLE
ENERGY FOR ALL


swera


THINK
GEOENERGY


UNDP


WASA


WMO

www.irena.org/globalatlas

potentials@irena.org

www.facebook.com/GlobalAtlasSolarandWind

www.irena.org/newsroom


Global Atlas
FOR RENEWABLE ENERGY

www.irena.org/globalatlas

P.O. Box 236, Abu Dhabi
United Arab Emirates

www.irena.org