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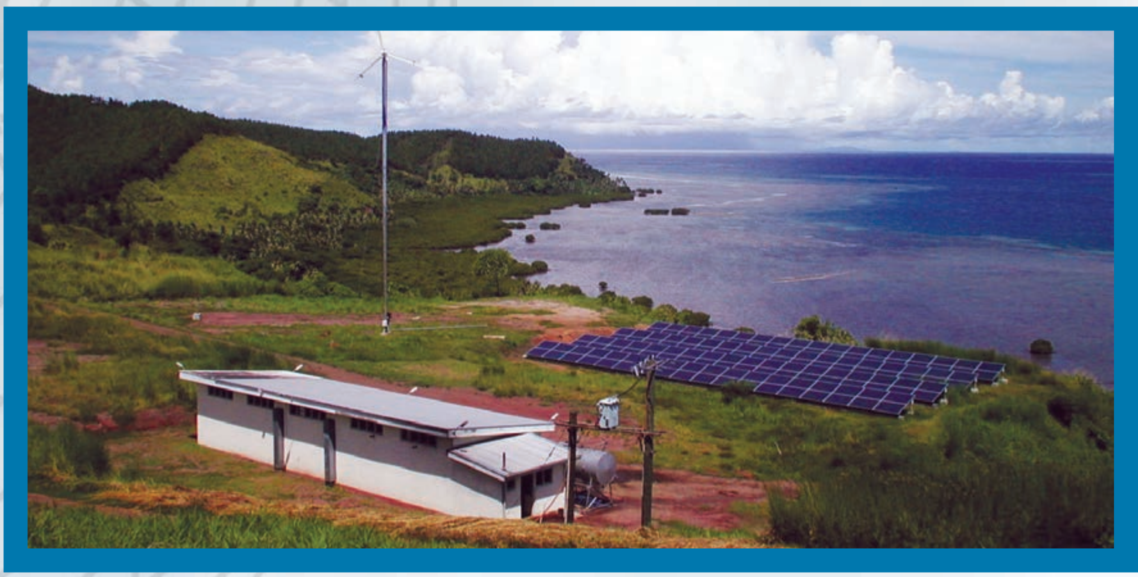
Insights from Interviews, a Survey, and a Workshop with Potential End-Users of the Global Atlas for Solar and Wind Energy



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About IRENA, the International Renewable Energy Agency

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. 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.

Knowledge, Policy and Finance Centre

IRENA's Knowledge, Policy and Finance Centre (KPFC) is a global knowledge repository and centre of excellence for renewables policy and finance issues, providing a 'one-stop shop' for statistics on costs, employment and resource potential, along with research on policies, investment frameworks and socio-economic and environmental impact for renewable energy technologies. Through this division, IRENA analyses economic value creation, including income, jobs, fiscal transfers, balance of trade and local/regional context, and supports policy makers with tools to maximise the renewable energy value chain.

One project led by the division is the Global Renewable Energy Atlas, the largest-ever initiative to assess renewables potential worldwide. The Internet-based platform provides high-quality resource maps from leading technical institutes worldwide and simplified models for evaluating technical potential. The Global Atlas aims to become the first reference point for renewable resource data and a catalyst for planning, policy development and investment in emerging and new renewable energy markets.

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Acknowledgements

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Executive summary

In partnership with a number of other groups, the United Nations Environment Programme (UNEP) is currently contributing to the development of a platform coordinated by the International Renewable Energy Agency (IRENA). The platform is aimed at sharing a global public-domain data set that includes information on renewable energy resource potential as well as relevant socio-economic and policy information. The purpose of the platform, called the *Global Atlas for Solar and Wind Energy (Global Atlas)*[1], is to facilitate the deployment of renewable energy technologies by providing access to relevant data.

The Global Atlas initiative is a large international effort initiated by Denmark, Germany and Spain under the Clean Energy Ministerial. Thirty-nine countries are directly contributing to the initiative: Albania, Australia, Belgium, Denmark, Egypt, Ethiopia, France, The Gambia, Germany, Grenada, Honduras, India, Iraq, Israel, Kuwait, Lithuania, Mali, Mexico, Mongolia, Nicaragua, Niger, Nigeria, Norway, Peru, Qatar, Saudi Arabia, Senegal, Seychelles, South Africa, Spain, Swaziland, Switzerland, Tunisia, Uganda, the United Arab Emirates, the United Kingdom, the United States, Uruguay, and Yemen.

The first version of the Internet-based platform was released in January 2013. It is designed to raise awareness of technology opportunities, to limit the financial risk for countries willing to investigate their technical potentials more thoroughly and to inform companies willing to invest in a new market. It will initially focus on wind and solar energies, to progressively include other renewable energy resources. The core technical group of the Global Atlas involves the National Renewable Energy Centre of Spain (CENER), German Aerospace Centre (DLR), DTU Wind Energy, Geomodel Solar, European Commission's Joint Research Centre (JRC), Mines ParisTech, Masdar Institute of Science and Technology, National Renewable Energy Laboratory (NREL), Renewable Energy and Energy Efficiency Partnership (REEEP), Renewable Energy Policy Network for the 21st Century (REN21), Prognos and Deutsche WindGuard. In addition, a number of institutes, organisations and agencies contribute to the programme by sharing data, manpower and expertise[2].

The Global Atlas gives access to high-quality resource maps from leading technical institutes worldwide as well as simplified models for evaluating the technical potential of these resources. The data set is enriched by more detailed national atlases that are validated against measurement data. This platform is intended to become a repository for high-quality renewable energy resource data and serve as a catalyst to trigger planning and policy development and attract investors in emerging and new renewable energy markets.

For the programme, UNEP and IRENA are jointly responsible for the consultation and involvement of the end-users in order to define the scope and limits of the initiative. UNEP interviewed users of a similar UNEP programme: the Solar and Wind Energy Resource Assessment (SWERA).

SWERA started 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. Its expanded mission was to provide high quality information on renewable energy resources for countries and regions around the world, along with the tools needed to apply these data in ways that facilitate renewable energy policies and investments. The results of the SWERA programme are hosted by NREL and OpenEI. The datasets and overall approach are incorporated into the Global Atlas. Next, UNEP invited potential end-users to complete an online survey about their general data needs between late 2011 and early 2012. These results are described below. They are complemented by the outcomes of a workshop on end-user expectations regarding the Global Atlas.

Insights from interviews

UNEP interviewed nearly two dozen end-users involved with the development of the SWERA project and/or interested in renewable energy resource mapping. Approximately half of the interviewees were policymakers and half were researchers. A few interviewees work in Asia/Oceania, but most interviewees are active in either Africa or Central and

[1] http://www.irena.org/GlobalAtlas
[2] The partnership is expanding and is regularly updated at: http://www.irena.org/GlobalAtlas/partnership.html

South America. The interviews were designed to identify the most useful elements of SWERA and determine which types of data, data formats and accessibility features would make the Global Atlas a success.

The interviewees had used the SWERA data and tools as a first step in gathering information and identifying locations with high potential for renewable energy development in their respective countries. All interviewees were familiar with all SWERA products, although their level of expertise and the frequency with which they used the SWERA tools varied. Users that did not have the software or expertise required to do their own Geographic Information Systems (GIS) analysis have relied on the Renewable Energy Explorer (RREx) or the GeoSpatial Toolkit (GsT) to look up information. Advanced users equipped with the necessary software conducted their own analyses using geo-referenced datasets (GIS layers) downloaded from SWERA.

The interviewees provided some useful insights about desirable features of the Global Atlas, and also revealed that different users likely to approach it with different needs and expectations – some of which will even be at direct odds. For example, some users suggested that the Global Atlas provide data on renewable energy potentials only; others suggested it provide a wider range of data. The most requested solar parameters were Direct Normal Irradiance (DNI), Global Horizontal Irradiance (GHI) and Latitude Tilted Irradiance. The most requested wind parameters were wind velocity, power density and wind direction.

While all users requested higher resolution spatial data, there was more variation in the responses concerning required temporal resolution. The differences in desired data resolution illuminate the different types of needs of different end-users (e.g. someone trying to understand if their local region would potentially be a good location for a generating power from wind or solar energy versus a project developer trying to select the most productive site for a project).

Survey responses

Approximately 100 potential Global Atlas end-users (including nearly 30 project developers) answered a series of questions about the types of data they would use and how they would prefer to access the data. These survey respondents were asked to rate the level of importance of over 20 specific wind and solar parameters and approximately 50 other relevant parameters. They provided responses ranging from "not important" (which received a score of "1") to "very important" (which received a score of "5"). A variety of types of end-users responded to the survey. Project developers are a target audience of the Global Atlas, which could be used as a site-screening tool for feasibility studies. As such, project developers' responses to the survey were analysed separately for insights about their specific needs. Generally, the responses of project developers were consistent with (and therefore representative of) those of all survey respondents.

The survey responses illustrate that dozens of solar and wind parameters are important. While it is useful to note that generally, any resource potential data, or data about any of the energy, risk, policy or economic indicators, are important to prospective Global Atlas users; it is also helpful to identify those parameters that the survey respondents rated as most important. The simplest approach to ranking the importance of all of the parameters in a given category (e.g. solar parameters or risk indicators) is to calculate the mean rating for each parameter. The basic assumption is that the higher the mean rating, the more important the parameter or indicator. Table ES1 presents a summary of the three most important parameters (the mean rating is shown in italics in the lower right corner of each cell in the table), as rated by all survey respondents (columns 2 -5 in grey) as well as by project developers (columns 4-6 in blue). For the most part, the responses of the project developers were consistent with those of all survey respondents.

Several solar parameters that are particularly important to project developers include GHI, DNI, Latitude Tilt Irradiance and sunshine hours. The three particularly important wind parameters are wind speed distribution, mean wind velocity and wind speed distribution by direction sector. Both the spatial and temporal resolution of wind and solar data appear to be important to project developers. When asked to select from a list of options the highest resolution data they would use , their responses trended toward the options with the highest resolution (e.g. hourly data for both wind and solar and 100 m grid cells for wind data).

In addition to wind and solar potentials, project developers indicated that numerous energy indicators and policy indicators were very important. Several general indicators (e.g. population density), risk indicators (e.g. political stability) and supplemental map layers (e.g. power lines and substations) are also important to them. Socio-economic parameters, particularly those characterising poverty levels, are less important to project developers than all other parameters mentioned in the survey.

A series of figures provided in this document provides a comprehensive illustration of how project developers rated the importance of each of the over 75 wind, solar, policy and other indicators mentioned in the survey.

Not only do the figures illustrate which parameters are particularly important (as indicated by the mean rating), they also illustrate that a single parameter might be rated both as "very important [5]" and "not important" [1] by a large portion of survey respondents. Generally, all of the parameters are important to a certain degree; all but six parameters received a rating at least as high as "important [3]" by over 75% of project developers.

Table ES1. Comparison of survey results between all participants and project developers: top three most important parameters (as defined by the mean rating); a rating of 5 means "very important" and a rating of 1 means "not important".

	All participants			**Project developers**		
	First	**Second**	**Third**	**First**	**Second**	**Third**
Solar Parameters	Global Horizontal Irradiance	Direct Normal Irradiance	Uncertainty in the data on the above parameters	Global Horizontal Irradiance	Sunshine hours	Direct Normal Irradiance; Latitude Tilt Irradiance
mean	4.61	4.58	4.37	4.55	4.52	4.47
Wind Parameters	Mean wind velocity	Wind speed distribution (given by for example Weibull A and k parameters)	Time series data of wind velocity	Wind speed distribution (given by for example Weibull A and k parameters)	Wind speed distribution by direction sector (given by for example Weibull A and k parameters)	Mean wind velocity
mean	4.58	4.53	4.35	4.50	4.36	4.33
Map Layers	Populated areas	Protected areas	Infrastructure power lines and substations; Land cover / Land use	Infrastructure power lines and substations Land cover / Land use	Populated areas	Protected areas
mean	4.23	4.21	4.15	4.08	3.96	3.87
Energy indicators	Infrastructures (electricity transmission and distribution lines)	Energy prices (country or state level)	Electricity - Installed capacity of solar power plants	Energy prices (country or state level)	Electricity - Installed capacity of solar power plants	Electricity - Installed capacity of wind power plants
mean	4.44	4.42	4.33	4.46	4.19	4.16
Policy indicators	Policies and support mechanisms	Regulatory framework and approval processes	Regulatory or administrative barriers	Policies and support mechanisms	Regulatory framework and approval processes	Regulatory or administrative barriers mean
mean	4.25	4.22	4.20	4.24	4.21	4.16
General and Economic indicators	Population density (province)	Natural hazards (country or state)	Infrastructures (roads and railways)	Population density (province)	Natural hazards (country or state)	Infrastructures (roads and railways)
mean	4.04	4.01	4.00	3.86	3.86	3.76
Risk indicators	Financial risk index (e.g. country credit rating)	Governance risk index (e.g. political stability, corruption)	Security risk index (e.g. absence of violence, terrorism)	Governance risk index (e.g. political stability, corruption)	Financial risk index (e.g. country credit rating)	Security risk index (e.g. absence of violence, terrorism)
mean	3.90	3.87	3.75	3.91	3.85	3.82

Workshop on end-user expectations

In January 2012, IRENA held a workshop to explore end-user expectations regarding the Global Atlas, targeting governmental organisations. Out of the 63 participants, about half were civil servants from ministries or embassies.

The full workshop summary is reproduced in the appendix. The workshop participants suggested that the Global Atlas should first perform an initial analysis of the renewable energy potentials and highlight the technical opportunities at different geographic scales (country, region) with a consistent and systematic approach. This initial analysis might highlight areas of particular interests and provide a simple ranking of those areas based on a number of simple and transparent parameters.

The information contained within the atlas should be peer-reviewed, of high resolution, accurate, validated through state-of-the-art methodologies, documented and updated. Additionally, it should provide information on the data quality and the uncertainty of the information.

Participants noted that simple tools would be needed to provide a basis for decision-making for governments. Such tools could, for instance, estimate technical potential for renewable energy deployment, provide information of a possible energy mix for a country, provide data on carbon dioxide (CO2) emissions and evaluate the potential for rural electrification and job opportunities. Investors, developers and utilities might be interested in the system if it could be used to initiate pre-feasibility studies of large installations and help feasibility studies for small-scale projects. This would require including information on national policies and legal frameworks, market conditions, custom tariffs or infrastructure situations.

Conclusions and recommendations

Bringing together the expectations from interview, survey and workshop participants allowed for drawing of some broad conclusions for the design of the Global Atlas:

- » The Global Atlas is expected to fill in the gaps in currently available data, provide planning and analytical tools and create a stimulus for attracting the attention of policymakers, developers, utilities and investors alike. The atlas shall be seen as a prospection tool, and it cannot be used for final investment decisions.
- » The Global Atlas data should be accessible both online and offline (downloadable), as many end-users work in remote locations with limited or no access to the Internet (or within countries that have inconsistent Internet connections).
- » The Global Atlas tools should be easy to use and also provide advanced features for more experienced users. Users of the Global Atlas will want to know about any uncertainties and limitations of the data, as well as how the data sets are created and the accuracy and appropriate use of the data. They would also like to have instructions for using tools.
- » Users would like to obtain a wide range of resource parameters and supplementary indicators through the Global Atlas. The most important solar parameters are DNI and GHI. Key wind parameters are wind speed (distribution) and wind direction (distribution). The most requested supplementary indicators are shown in table ES1 above.
- » In the future, the Global Atlas should cover other renewable energy sources as well.

I. Introduction

The Clean Energy Ministerial Multilateral Solar and Wind Working Group was developed to promote accelerated deployment of solar and wind technologies. The Working Group, which is led by the governments of Denmark, Germany and Spain, is launching projects based on recommendations from the Technology Action Plans (TAPs) for Solar and Wind Technologies, which were developed by the Global Partnership on low-carbon and climate-friendly technologies of the Major Economies Forum.

One of the initial objectives of the group was to develop a platform/web portal for sharing a global, public-domain data, including information on renewable energy resource and potentials as well as relevant socio-economic and policy information. This platform/web portal, called *the Global Atlas for Solar and Wind Energy (Global Atlas),* would facilitate the deployment of renewable energy technologies and attract investment for this sector. Its goal was to share information on renewable energy potentials, the related socio-economic policies and conditions by means of a unified, high-resolution, public-domain global data set.

There have been several previous examples of providing renewable resource information in the past, but these approaches were much more fragmented mainly in geospatial and technology coverage. These included Task 36 within the International Energy Agency (IEA) Solar Heating and Cooling Implementing Agreement and the European Project Management and Exploitation of Solar Resource Knowledge (MESoR). An evaluation of these projects showed that providing solar resource data on internet platforms is highly beneficial and users appreciate harmonisation of the data.[3]

The Global Atlas has many target audiences, representing varying levels of familiarity with the data types and the ways in which the data can be used. The Working Group wants to ensure that its Global Atlas meets the needs of developing country policymakers and renewable energy developers seeking to enter emerging markets.

Therefore, the United Nations Environment Programme (UNEP) sought feedback on elements that could increase the utility of the data included in the Global Atlas (and the web portal by which users will access the Global Atlas) based on insights gained from end-users of UNEP's SWERA data and tools. To this end, UNEP interviewed selected SWERA end-users and conducted an online survey of a broader user base. This report outlines the users interviewed, summarises the findings from the telephone and email interviews, summarises the results of the online survey and provides data and graphics of the survey results.

These results are complemented by the outcomes of a workshop on end-user expectations with respect to the Global Atlas held by IRENA in partnership with the Clean Energy Ministerial Multilateral Solar and Wind Working Group in Abu Dhabi in January 2012. The full workshop summary is reproduced in the appendix.

[3] See Huld T, Šúri M, Meyer R, et al. (2007), Customers' requirements of solar energy resource information: results of the IEA SHC Task 36 online survey. IEA Solar Heating and Cooling Programme (SHC) Task-36, http://www.geoss-ecp.org/sections/solar/iea-shc-task36-survey-on/downloadFile/file/IEA-SHC-Task36-survey-data-eeds_v5.pdf?nocache=1196246135.04 and MESoR (Management and Exploitation of Solar Resource Knowledge). http://mesor.net.

II. User interviews

UNEP interviewed a selection of end-users who are, or have been, involved with the development of the SWERA project. Interviewees also included users interested in renewable energy resource mapping. Most of the interviewees were policymakers or researchers who collaborated with their ministries of energy, representing geographically diverse regions. The interviews were designed to identify the most useful elements of SWERA and ways to improve data use in order to stimulate renewable deployment in the users' countries. Table 1 lists the names of the interviewees; Table 2 summarises their affiliations and geographic areas of interest.

Table 1. SWERA Users Interviewed

Country	Type of User
Guatemala	Policymaker, Ministry of Energy
Nicaragua	Policymaker, Ministry of Energy
Costa Rica (Activity in all Central-America)	NGO, BUN-CA, Fundación Red de Energía
Brazil	Researcher, Universidade Federal de Santa Caterina
Brazil	Researcher, Instituto Nacional de Pesquisas Espaciais
Brazil	Researcher, Universidade Federal de Santa Caterina
Chile–Brazil	Researcher, Universidade Federal de Santa Caterina
Chile	Researcher, Universidad de Chile and INPE
El Salvador	Researchers, Consejo Nacional de Energía
Nepal	Policymaker, Alternative Energy Promotion Center
Nepal	Policymaker, Alternative Energy Promotion Centre
Indonesia	Researcher, P3TKEBTKE
Kenya	Policymaker, Ministry of Energy and NGO
Ghana	Researcher, Kwame Nkrurmah University of Science and Technology

African and Asian Mediterranean Coast	Policymaker, RCREEE, Regional Center for Renewable Energy and Energy Efficiency
West Africa	Policymaker, ECREEE, ECOWAS Regional Center for Renewable Energy and Energy Efficiency
South Africa	Researcher, South African National Energy Research Institute
South Africa	Policymaker, SADC, Southern African Development Community
Botswana	Policymaker, SADC, Southern African Development Community)
Namibia	Researcher, Polytechnic of Namibia - RE and EE Institute
Micronesia	Policymaker, SPC, Secretary of the Pacific Community

Table 2. Interviewee Profile

Type of Users	Geographic Location
11 policymakers	4 Central America
10 researchers	5 South America
1 non-governmental organisation (NGO)	9 Africa
	3 Asia
	1 Oceania

III. Interview findings and recommendations from SWERA users

Every person interviewed had used all of the tools available through SWERA, but with varying frequency.

Users cited the level of complexity of the tools as one of the factors influencing their use. The availability of adequate software has indeed been critical for users when choosing certain tools. For example, some users do not have experience with advanced software such as Geographic Information Systems (GIS), so they have used the online GIS tool known as Renewable Resource Energy Explorer (RREx) or the downloadable GeoSpatial Toolkit (GsT). These simpler tools do not allow them to do advanced analyses or calculations rather they allowed them only to look up information.

The RREx is said to be intuitive and to allow quick access to the data. The GsT, which reveals overlaying data (e.g. resource data, transmission lines, protected areas), was useful in providing a better and more in-depth overview as to possible locations for further studies.

More experienced users who are familiar with GIS softwares download the GIS layers available through the SWERA site to perform their own calculations and assessments. They are able to evaluate project opportunities and assess the resource availability. Users from Nepal and Indonesia report that some companies take the SWERA resource data a step further by using it within other software platforms, such as Windographer, RETscreen and HOMER.

Users from Nepal and Guatemala expressed a need to access SWERA data in rural areas to simplify their work. In this context, the GsT is more useful than online navigation. These remote locations have restricted access to the Internet, and users need to download the data for future use in the field. Moreover, some regions do not have reliable Internet connections, so the downloadable tools and data are very important options. One user from Brazil affirms that some developers and investors (who do not have GIS software or do not know how to use it) prefer to download information in graphic format (pictures in .pdf or .jpg format). This allows them to have quick access to the information in order to identify areas with the highest potential for solar and wind development.

A. SWERA ISSUES

1. Data availability

Seven interviewees cited the low resolution of the data references in SWERA as an important issue, and requested that data be delivered at a higher spatial resolution. For example, although SWERA was not applied to the Pacific Ocean's islands, the interviewee from Micronesia stated that he would need the data to be delivered at high resolution because of the small surface area of Micronesia. Another user stated that the successful and sustainable development of an energy wind project requires minute-by-minute data (rather than monthly or annual averages) in order to calculate the exact potential for a location.

Two additional users from Brazil reported that improving the quality and increasing the number of sites with Typical Meteorological Year (TMY) files would be useful for the community using the National Renewable Energy Laboratory's System Advisor Model (NREL SAM) and Transient System Simulation Tool (TRNSYS) for hourly simulations.

These users expected SWERA to meet project development needs, which was out of the scope of the programme. This could point to a miscommunication of the purpose and usefulness of SWERA data.

2. Data reliability

The interviewee from Guatemala stated that there were important differences between the resource information presented in SWERA and the ground measurements. Guatemala has performed resource measurements for two years, which showed lower values than those provided by SWERA. One reason for this difference is that many SWERA products were developed through meso-scale modelling approaches and completed in the absence of ground data. Comparisons of meso-scale modelling and ground data are always needed to validate the datasets. The fact that subsequent ground measurements were taken is a positive outcome of SWERA, in an effort to validate the available datasets.

A Brazilian user from the energy-efficient building sector had used the SWERA climate data and stated that it was not very reliable. The climate data being provided by low-resolution global data set from the National Aeronautics and Space Administration (NASA) that was however not part of the key focal areas of SWERA. It was included as a reference data set for interested parties.

3. Data access

Most users said they did not encounter any problems with the web portal, some had experienced difficulties downloading data. In some cases, for example in Kenya, the user encountered download failure due to the large size of data files and the user's limited Internet connection. In Brazil, due to a lack of computing knowledge, some users requested help from the core SWERA partner, Instituto Nacional de Pesquisas Espaciais (Brazilian Space Agency), in order to be able to use the information.

One user from Brazil also said that deficiencies in the description and instructions for using the information could lead to usage errors. For example, some of the units of measure indicated in the description files were not the units of measure of the actual data. Some cells had missing data, which caused difficulties in data handling.

Finally, another user from Brazil stated that SWERA use was not widespread in his country and more outreach and education activities should have accompanied data development to realise a greater impact, especially related to solar energy, which has not achieved high levels of deployment in Brazil.

B. USE IN PROJECTS

SWERA was intended to identify potentially suitable locations to build solar and wind energy projects. Most of the interviewed users (such as those from Nicaragua, Guatemala, Kenya, Brazil and Nepal) stressed the utility of SWERA as a first step to solar and wind energy deployment. Users reported gathering more data and verifying measurements on the ground in combination with obtaining SWERA data. For example, in Ghana, the SWERA solar resource maps helped researchers decide where to install weather stations for DNI ground measurements. Users from Nicaragua and El Salvador indicated that all of the renewable energy projects deployed in their countries were initially identified through data sets provided by SWERA. This information was used to decide where to install measurement stations for the gathering of more detailed data to inform further decisions.

In countries where solar energy is not highly developed, such as Brazil, SWERA has communicated the potential for solar energy to supply off grid renewable electricity and other projects. Therefore, SWERA data were used as the first step to planning the development of solar energy projects and policies. This feedback verifies the purpose and usefulness of SWERA, which is meant to provide initial data for such decisions.

Several universities in Nicaragua also use SWERA as a basic tool for teaching and as an instrument to develop their projects. In Brazil, SWERA has been used extensively in master's and doctorate programmes as well as other educational projects.

C. INFLUENCE ON POLICY

All interviewed users reported that SWERA has been a useful tool for increasing government awareness of renewable energy potential. These users noted that SWERA has helped identify regions in their countries with high potential for renewable energy generation and that it has demonstrated the viability of deploying these technologies.

However, not all users believed that SWERA data was directly used in the creation or modification of energy policies. Users from Kenya, El Salvador and Guatemala felt that it has only been useful in increasing the awareness of renewable energy potential among energy policymakers –in other words, that it has had no direct effect on the creation of policies.

Nonetheless, users from Nepal, Ghana, Brazil and Nicaragua assert that SWERA's information and knowledge has been used in preliminary assessments and as evidence in internal discussions related to the modification of energy policies. In these countries, SWERA has guided exploration and policy development, including implementation of feed-in tariffs.

D. CAPACITY-BUILDING ACTIONS

Among the users interviewed, consensus emerged regarding the necessity of incorporating capacity-building actions that teach users how to use SWERA tools and interpret SWERA data. Users suggested that these capacity-building actions should have targeted various groups, including policymakers, developers, NGOs and universities.

For example, users in Nepal reported that the impact of SWERA could have been greater with increased understanding of how to use the tools. The user from Guatemala suggested that capacity-building actions should include research technicians supporting policymakers because people holding political positions may change frequently.

Meanwhile, the user from Ghana said that it was best for academia to retain, update and spread such technical understanding. The user from Brazil felt that continuous workshops are needed to educate people to use the tools, and he would target the capacity-building actions to university students because they would be the future decision makers.

But the user from South Africa stated that capacity-building actions need to focus on all of the users who work with energy to ensure that they know how to use the tools and can apply the data to the work on the ground. One interviewee from the Economic Community of West African States Regional Centre for Renewable Energy and Energy Efficiency (ECREEE) suggested that capacity-building actions should be aimed at those directly engaged in national planning (i.e., national ministries) in order to improve planning and strategic development.

The user from Indonesia suggested gearing capacity-building actions toward energy and electricity companies to increase the awareness of investors and developers with regard to the renewable energy potential of a country.

The user from Namibia suggested that country institutions should identify their own needs so capacity-building actions could be adapted to the areas where stakeholders develop their work. One option is to include stakeholders in the capacity-building project as partners. Another is to coordinate these actions with regional institutions that can organise workshops and training for the countries within their work areas.

The South African Development Community (SADC) and ECREEE users suggested that capacity-building actions should be adapted to all knowledge levels in order to better plan, design and construct renewable energy projects, citing that the countries where they work lack renewable energy knowledge.

E. CONCLUSIONS AND RECOMMENDATIONS FROM SWERA USER INTERVIEWS

Based on users' feedback, it is clear that SWERA has been a useful tool for the development of solar and wind renewable energy in the original project countries – and beyond. The fact that it provides a suite of data and tools for application of the data is an added value. Users indicated that the SWERA data and tools have been used as a first step in gathering information and identifying locations with high potential for renewable energy development.

This suggests that increasing global coverage of renewable resource potential could have similar impacts in other countries not currently covered by the SWERA project. It could facilitate the development of renewable energy projects and creation of policies that incentivise this development.

Users' comments regarding resolution and reliability confirm the need to clearly communicate the uncertainty, limitations and appropriate uses of the data provided (i.e., site screening and not project development). The feedback also suggests that SWERA and similar initiatives can increase their impacts through effective capacity-building actions, which should include developing instructions for using tools, explaining how the data are created and improving the accuracy and appropriate use of the data.

IV. Interview findings and recommendations for the Global Atlas

This section outlines suggested improvements of the Global Atlas data functionality to meet the needs of its user community, based on the interviews of SWERA users as described above.

A. DATA DELIVERY FORMAT

All users agreed that the Global Atlas should be presented in a variety of formats in order to be most useful. Specifically, the interview findings suggest that the Global Atlas data should be accessible via (1) online browser, (2) downloadable data files, (3) desktop software tool and (4) printable map and graphic products.

For less advanced users, the browser-based option (i.e., a format similar to that used by Google Maps) is the most suitable because using the browser is the easiest way to access the mapped resource data. The browser-based option provides a simple path for seeking information such as topography, roads, transmission lines and protected areas. This provides users less experienced with GIS, such as many policymakers, a way to engage with and explore renewable resource data; the format permits all users to be able to do their own assessments with no concerns about their familiarity with geospatial and energy analysis software. This browser-based tool also allows users to easily display data wherever the Internet is accessible.

All interviewees also agreed that data must be downloadable. This format is needed for two main reasons. First, some users want to access data and use tools while they are working in the field, including locations where Internet access is not reliable or available. For these users, downloading the data beforehand is a necessity. Second, interviewees explained that users with advanced knowledge of GIS (mainly developers, researchers and government technicians) want to be able to download the GIS data and use it with their own software to perform calculations and assessments.

It is important to emphasise that in the first of these two situations, some users would still need to use offline data and that they may not be able to use the GIS files. Thus, a third option, an easy-to-use offline software tool, should also be designed (e.g. GsT). This software should allow users to overlap different data layers, as suggested by users from El Salvador.

Finally, the interviewees from Chile, Brazil, Namibia and ECREEE also requested that Global Atlas information be printable so it can be used as a quick reference (e.g. maps, tables and documents in .pdf format). They stated that users would appreciate having tools that facilitate map creation and the view of overlapping data layers, as well as simple document distribution to decision makers.

B. PORTAL EXPECTATIONS

According to interview results, the Global Atlas portal should contain high-quality, high-resolution data. In addition to providing information about the availability of resources, the Global Atlas should also supply information related to socio-economic conditions for each country. It needs to be easy to use for experts and non-experts alike, and it should provide tools for creating power production simulations and countrywide estimates of economically viable renewable potential.

A user from Brazil stated that capabilities to analyse economic viability of small renewable energy projects would increase the impact of the Global Atlas. Users from El Salvador suggested that the Global Atlas be simple and fast, noting that including too much data on-screen can impede performance. The interviewees from ECREEE emphasised the importance of reliable data that would help countries move from rough planning to feasibility studies. They said that the Global Atlas should provide enough data to enable investment decisions for exploration of potential solar and wind energy development areas.

Users from SADC and South Africa said that the Global Atlas will have added value if it incorporates the ability to gather and integrate various databases and different useful topical information in a single portal. A tool that only provides solar and wind data will not improve other databases and portals that are already available. Rather, according to these users, the Global Atlas needs to provide additional information about appropriate uses and tools that can use the solar and wind data.

Although some users suggested that the Global Atlas should contain additional information, others disagreed. Users from Namibia and Micronesia said that the Global Atlas should offer only essential information and provide basic data and provide links for additional information.

SADC users stated that the Global Atlas will help the development of technologies and policies related to solar energy, which is not yet popular in their region. The user from Namibia affirmed that this initiative will provide a platform to share the experiences of countries with extensive renewable energy knowledge and deployment experience to help advance the knowledge of others.

ECREEE users stated that the Global Atlas needs to answer what, where and how users can access the available renewable energy resources in the most economical manner, in such a way that causes the least adverse environmental impact. They expect the high-quality and reliable Global Atlas data to be useful to convince governments to commit to the deployment of renewable energy. However, only a few users, those from South Africa, acknowledged that they understood the real purpose of the atlas data – to provide initial screening information, after which further assessments and measurements will be needed.

When users were asked about the most important elements that this tool should have, they made specific requests about their own country or working area. For example, users from Brazil requested that the Global Atlas portal and tools be translated to Portuguese. Users from Nepal requested tools that can be adapted to work in places with complex terrain.

The Biomass Users Network's Central America regional manager suggested a dissemination approach that includes identifying relevant international databases and providing links to the Global Atlas through those sites.

Regarding capacity-building actions, one of the suggestions from the Chile-Brazil interviewee was to hold training sessions about renewable energy fundamentals in countries where they are not well known. One user from Brazil suggested publishing online videos with instructions for using the Global Atlas.

C. SOLAR AND WIND PARAMETERS

Users provided information about the specific parameters they would like to see in the Global Atlas for use in conducting simulations. For solar energy, the most requested parameters were all measures of radiation, including DNI, Global GHI and Latitude Tilted Irradiance, though some users rated DHI as less important. Regarding wind parameters, the most requested parameters were wind velocity, power density and wind direction. Users from Nepal and Brazil also requested some climate parameters such as temperature, pressure, humidity, rain and visible light (for users interested in developing sustainable buildings).

Generally, interviewees requested the ability to receive energy-potential data and its relation with the renewable energy resource data. This would help users understand the amount of energy that could be generated by building a solar or wind installation, which would be very useful for non-experts. According to all interviewees, the level of uncertainty should be defined for all parameters.

D. IMAGE RESOLUTION AND DATA INTERVALS

All users requested higher spatial resolution than what is available through SWERA. The lowest spatial resolution request came from a Brazilian user who asked for resolution of 1 km x 1 km. In contrast, the user from Micronesia stated that the Pacific Islands need a higher resolution of 100 m x 100 m.

Some users (from Brazil, Nepal, Nicaragua, Guatemala, ECREEE and Indonesia) requested annual, monthly and daily averages, while others requested hourly data represented in a long series because time series information is very important to calculate resource potential, especially with wind data (which is important to users in Micronesia). The researcher from Namibia requested 10 years of data with the most possible time intervals (by hour and minute).

E. SOCIO-ECONOMIC AND POLICY PARAMETERS

All users agreed that socio-economic and policy parameters would be useful to gain a better understanding of the implications for various solar and wind deployment scenarios. They agreed that this data needed to be summarised and simply displayed within the Global Atlas portal, and that it needs to be updated periodically. These needs notwithstanding, the amount of parameter-related data generated should not exceed a certain amount, or users will experience problems updating and downloading the data in areas of poor Internet connections.

The user from Micronesia felt that no additional data should be included because it is also available from other sources and that instead, the energy resource data should be developed further.

Socio-economic and policy information suggestions fell into four main groups: (1) data displayed in layers; (2) energy data; (3) established energy policies; and (4) socio-economic development scenarios.

Users requested layers related to the electricity distribution network (e.g. high-voltage lines, substations, other electric infrastructures), roads and transport routes, population (density), protected areas, water masses, areas with physical constraints, off-grid school and hospital locations, poverty area locations and restricted areas due to terrain, etc. One user from Nicaragua suggested providing a tool to calculate the distance between a high-resource area and a transmission line.

The suggested energy data included parameters such as energy consumption and generation, installed capacity of different energy sources, electrification ratios, energy demands, energy prices, regulatory framework and government objectives.

Suggested parameters for established energy policies addressed fiscal incentives, including subsidies and feed-in tariffs. ECREEE's user said that direct descriptions from policy data sources can be too complex, but providing only information of their existence is not enough. Rather, he suggested creating layers with the countries' energy prices and feed-in tariffs and then allowing for users to overlay the data with cost of renewable energy generation at various locations, which would be useful for an initial screening.

Finally, suggestions for socio-economic scenario parameters included poverty levels, risk indicators and information about opportunities for economic development.

There was a consensus among users that the web portal should offer access to tools that allow them to perform their own simulations (considering parameters such as energy potential, project development and economic and financial studies) using data from several of the previously mentioned categories.

F. CONNECTIVITY ISSUES

Some users (those from Guatemala, Chile-Brazil, ECREEE and SADC countries, South Africa, Indonesia and Micronesia) reported that they experience connectivity issues when using online tools. Despite this issue, the tools still need to be online because they can be updated periodically. In light of these potential problems, they all suggested an option to use the Global Atlas offline, so they would be able to continue work in the field or in cases of Internet outages. Users suggested that data and tools could be distributed on DVDs or USB external drives.

G. GLOBAL ATLAS CONCLUSIONS AND RECOMMENDATIONS

Users want a Global Atlas that can be used online and offline. Because the Global Atlas is expected to have a broad range of users with widely different levels of expertise, its tools should cater to both the inexperienced and advanced user.

Based on the interviews, the Global Atlas initiative needs to focus on providing solar and wind resource data. However, the inclusion of energy potential data is also desirable because it provides less sophisticated users with estimates of the amount of energy a solar or wind installation may generate at a specified location. Including socio-economic and policy data is also important and provides additional information that will give users an improved understanding of the solar and wind energy deployment scenarios, enabling them to make better decisions. The parameters need to be selected carefully in order to provide the most important and useful information. In addition, interview results determined that the Global Atlas spatial resolution needs to be high, although the requested spatial scale varied from user to user.

Finally, when users access the Global Atlas, clarification must be provided stating that the information provided by the portal must be validated with additional ground measurements, and that some level of uncertainty is always associated with the presented data.

V. Global atlas for solar and wind energy: findings from the end-user survey

The purpose of this section is to provide a general summary of the survey responses and identify key insights. The target group of the survey was project developers, and as such, they are the focus of this section of the document. As appropriate, additional trends identified from the entire respondent pool or other subsets are described for comparison.

A. OVERVIEW OF SURVEY RESPONDENTS

Of the 195 responses to the survey, approximately half (101) were "complete" (surveys were deemed complete if they provided ranking for any of the parameter inclusion questions).

1.Types of organisations

Respondents were asked to describe their organisations' roles in renewable energy development and could select multiple answers. The majority of respondents (63%) described themselves as using at least one of the following terms: consultant, energy modeller, project developer and researcher/educator. Figure 1 shows the breakdown of the types of organisations represented by the survey respondents.

Project developers represent one of the primary audiences the project team would like to reach with the Global Atlas. As shown in Figure 2, of the 29 respondents that classified their organisations' roles as project developers, many also described themselves as consultants (18) and/or energy planners (11).

2. Regional representation

Respondents were asked to identify the principal world regions where their development activities are taking place (multiple locations could be selected). While a fraction (less than 25%) of the project developers work worldwide, the sub-regions they reported with the most activity were Europe, South America, North America, South and East Asia and Africa (Figure 3). Regional activity for project developers, shown in Figure 3, is representative (proportionally) of the breakdown of regional activity across all survey respondents.

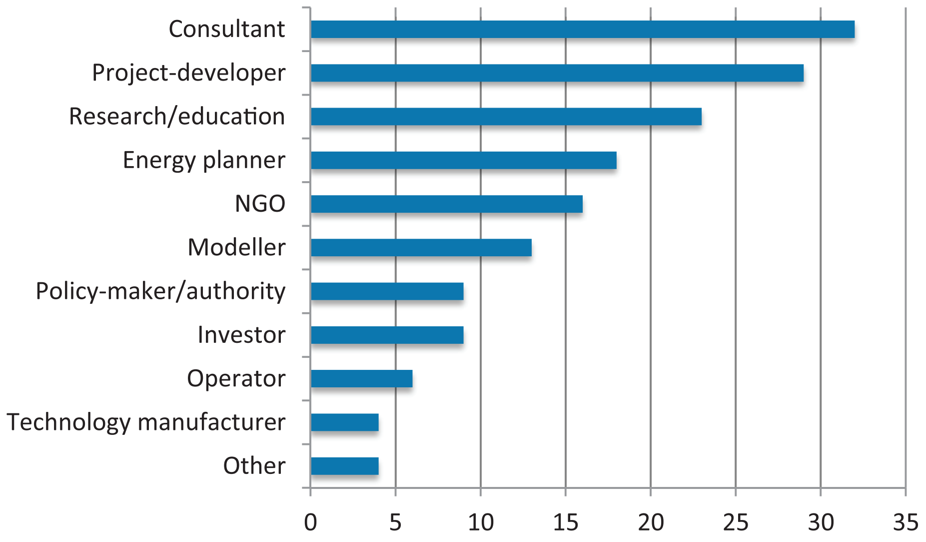


Figure 1.Types of organisations where respondents work (number of responses, not per cent)

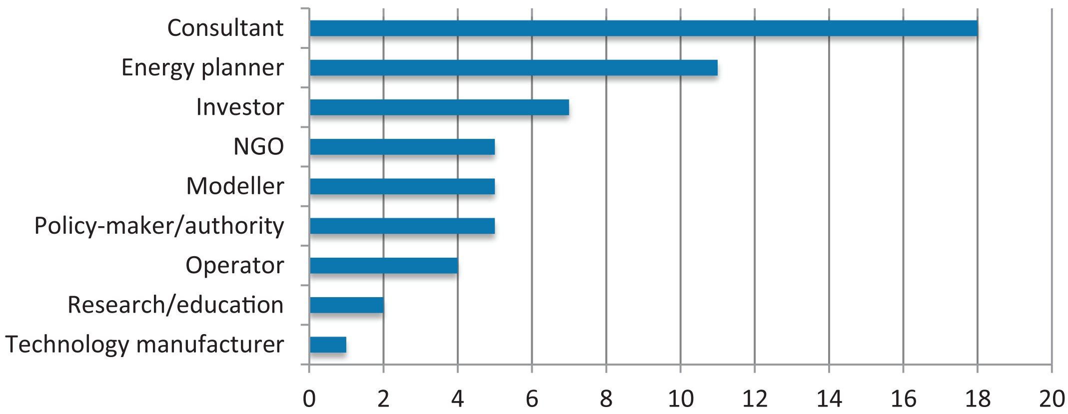


Figure 2. Project developers: additional terms they used to describe their organisations (number of responses, not per cent)

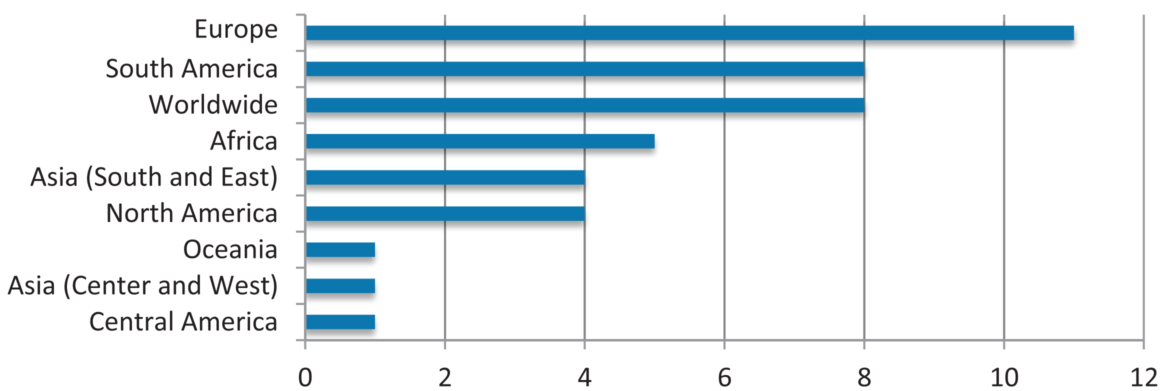


Figure 3. Project developers: locations of principal development activity (number of responses, not per cent)

B. FAMILIARITY WITH SWERA

Only a fraction of project developers (14%) had used SWERA before, which was lower than the portion of all survey respondents who had used SWERA (19%). All survey respondents were asked which SWERA products (e.g. interactive mapping or Geospatial Toolkits) they had used; the responses from all participants are summarised in Figure 4. Each of the SWERA products had been used before, although map downloads had been used by the most respondents.

Survey respondents were also asked to rate the usefulness of the SWERA products they had used, the results of which are shown in Table 3. While we can gain some insights from these ratings, it is worth noting that only a limited number of survey respondents had used SWERA previously and only a fraction provided ratings about the usefulness of those products.

As shown in Table 3, respondents found the GIS data downloads to be the most useful SWERA product (50% rated GIS data downloads as "very useful''). Respondents also rated Google Earth layers "relatively useful", with all ratings were between "somewhat useful" and "useful."

There was less consensus regarding the usefulness of the interactive mapping, Geospatial Toolkits and map downloads. Up to one-fifth (between 11% and 20%) of respondents found each of those products to be "not useful" or "minimally useful", yet up to one-third (between 20% and 33%) of all respondents found those very products to be either "very useful" or "useful."

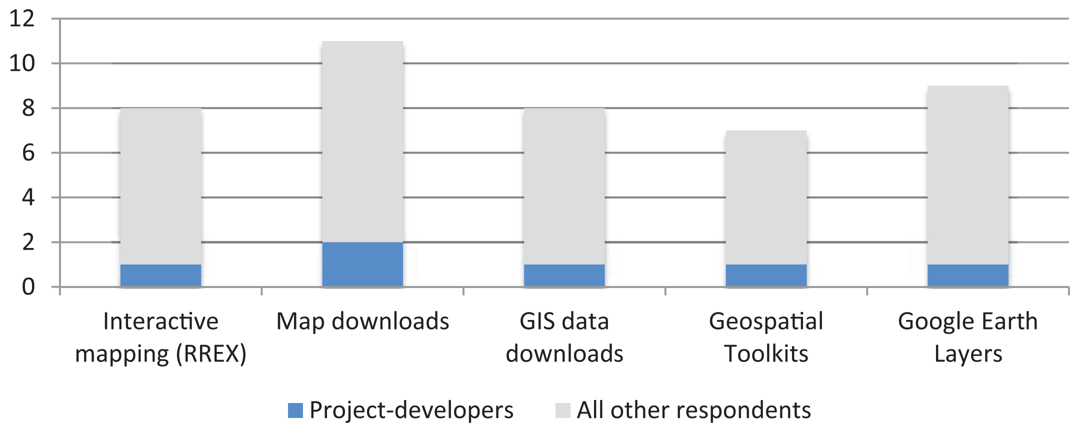


Figure 4. All survey respondents: use of SWERA products

C. PREFERENCES AND USES OF SOLAR DATA

One purpose of the Global Atlas is to provide a unified, high-resolution and public-domain global solar data set. Survey respondents were asked about their use of solar data.

1. Solar data currently used

Respondents were asked to list the sources they currently consult for solar data. The single most common answer among all respondents was NASA. A sample of additional sources is listed in Table 4 and includes Meteonorm, DLR and 3Tier. Several respondents indicated that they used their own measurements.

According to the survey responses, project developers rely on a wide array of sources for solar data. A few sources were listed by more than one project developer, specifically: NASA, PVGIS, Meteonorm and government sources.

	No Rating Provided	Rating Provided	Usefulness Ratings				
			Not useful	Minimally useful	Somewhat useful	Useful	Very useful
Interactive Mapping (RREx)	38%	63%	0%	40%	0%	40%	20%
Map Downloads	18%	82%	0%	11%	33%	22%	33%
GIS Data Downloads	25%	75%	0%	0%	17%	33%	50%
Geospatial Toolkits	29%	71%	20%	0%	40%	20%	20%
Google Earth Layers	22%	78%	0%	0%	43%	14%	43%

Table 3. All survey respondents: usefulness ratings of SWERA products

Solar Data Source ("Write-in" Responses)	No. of respondents
3Tier	4
DLR	5
DOE/EERE/NREL	11
Government sources/databases	6
Meteonorm	5
NASA	11
Own measurements/research	4
PVGIS	4
SolarGIS	2
* Researcher from NREL tallied these results and was familiar with all DOE-related responses, thus able to group them. It is possible that other "similar" tools were not identified appropriately, and therefore not grouped together for this table.	

Table 4. All respondents: sample of solar data sources currently used

2. General interest in solar data from the Global Atlas

When asked if they would use the data available from the Global Atlas, approximately 75% of project developers responded "yes," which was a higher percentage than across all survey respondents (almost 65% responded "yes"). Fewer project developers left the question blank; for both groups, only 3% of survey respondents answered "no."

3. Interest in specific solar parameters

Respondents were asked to rate the level of importance (ranging from "not important", which was given a score of "1", to "very important", which was given a score of "5") of specific solar parameters:

- Global Horizontal Irradiance
- Direct Normal Irradiance
- Latitude Tilt Irradiance
- Diffused Horizontal Irradiance
- Clear sky days
- Sunshine hours
- Climate conditions
- Frequency distributions of irradiance parameters
- Uncertainty in the data of these parameters

Out of 101, between 50 and 60 of all survey respondents provided ratings and out of 29, approximately 20 project developers provided ratings.

Results of the survey indicate that all of the parameters are relatively important. All were rated as either "quite important [4]" or "very important [5]" by nearly 75% of all survey respondents and by nearly 80% of project developers. None of the parameters were rated as "not important [1]", and no more than 6% of all survey respondents (or project developers) rated any of the parameters as "minimally important [2]".

a. Importance of solar parameters according to project developers

The full set of solar parameters and the project developers' ratings are displayed in Figure 5. The single parameter that was most consistently rated as "very important [5]" was GHI. GHI, sunshine hours, Latitude Tilt Irradiance and DNI parameters received the highest average ratings from project developers, all with a mean rating of 4.47 or higher.

The survey did not provide criteria for distinguishing "very important [5]" from "quite important [4]", so it is also worth noting which parameters were most consistently given either of those two ratings. Figure 5 shows the parameters listed that were given a rating of "quite important [4]" (dark blue) or "very important [5]" (light blue) by over 75%b of project developers that responded. Both sunshine hours and climate conditions were ranked as either "quite important [4]" or "very important [5]" by 90% of project developers, followed closely by uncertainty in the data (89%) and frequency distributions of irradiance (88%).

The parameter that project developers ranked as relatively less important than the others was DHI. Although it received the lowest mean rating (4.22), nearly 90% rated it at least "important [3]".

b. Importance of solar parameters according to all survey respondents

Consistent with the project developers' responses, GHI and DNI were the two parameters most often rated as "very important [5]" by all survey respondents.

The parameter that all respondents ranked as relatively less important than the others was Latitude Tilt Irradiance (although, over 90% rated it as at least "important [3]").

c. Other important solar parameters not originally listed on survey

Survey respondents were asked to list if there were other parameters that they would have ranked between "important [3]" and "very important [5]". Respondents provided approximately 15 different responses, but the few that were provided by more than one survey respondent were wind speed (two project developers), rain/moisture

[4] For an analysis of solar parameters by technologies (PV, solar heating, Concentrating Solar Power) and the question of which solar data in which resolutions should be made available in a portal like the Global Atlas, see: Huld T, Šúri M, Meyer R, et al. (2007), Customers' requirements of solar energy resource information: results of the IEA SHC Task 36 online survey. IEA SHC Task-36, http://www.geoss-ecp.org/sections/solar/iea-shc-task36-survey-on/downloadFile/file/IEA-SHC-Task36-survey-data-eeds_v5.pdf?nocache=1196246135.04.

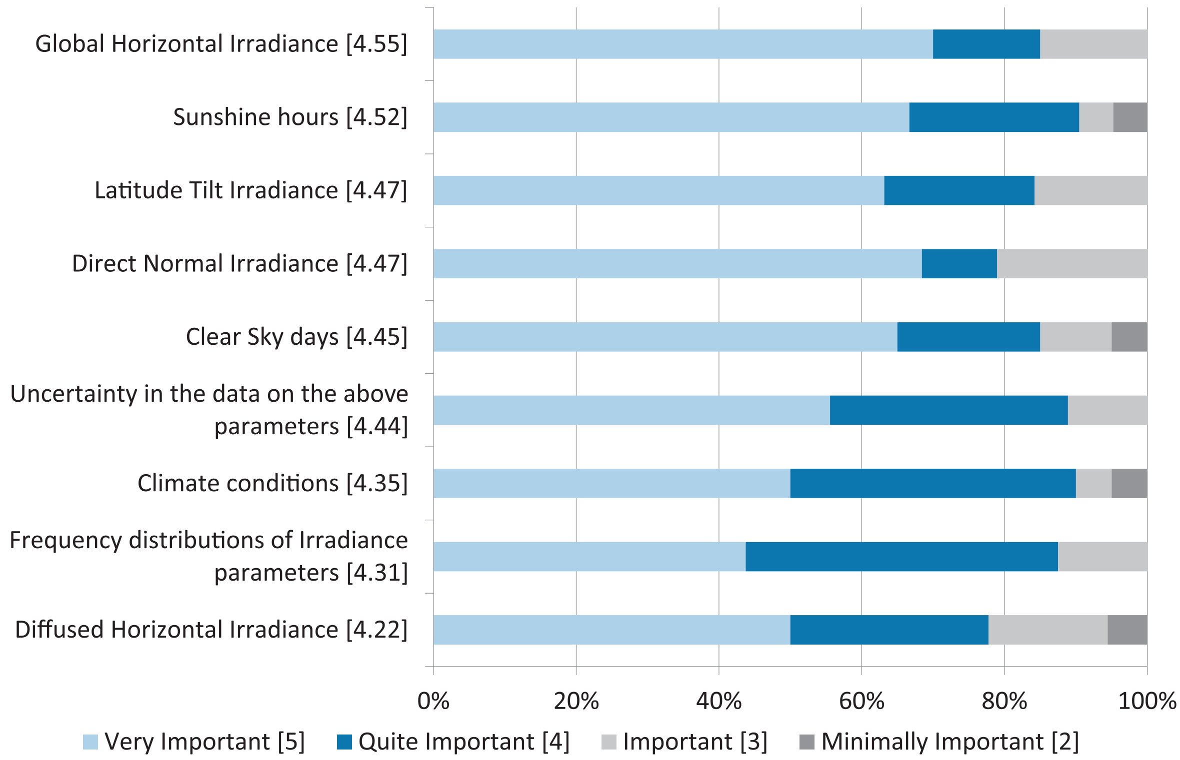


Figure 5. Project developers' responses: level of importance of specific solar parameters, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

(two project developers) and temperature (only one project developer).[4]

d. Temporal requirements for solar data

Survey respondents were asked to identify the highest temporal resolution relevant to their work. Exactly half of the responding project developers said that they need hourly data while just over 20% listed that monthly data would be sufficient (Figure 6).

Four survey respondents (two project developers) listed that they would prefer sub-hourly data (15-minute).

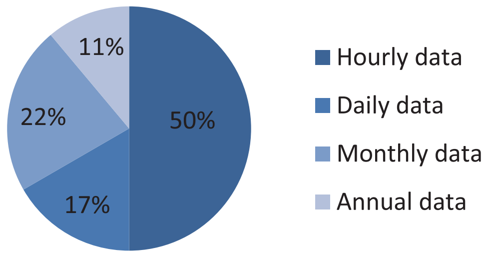


Figure 6. Project developers: highest temporal resolution desired for solar data

e. Spatial requirements for solar data

Survey respondents were asked to identify the highest spatial resolution relevant to their work. Over half of the project developers that answered the question listed that they need data at the 1 km grid scale (Figure 7).

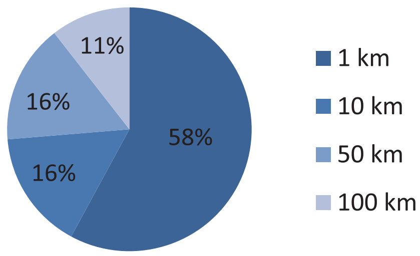


Figure 7. Project developers: highest spatial resolution desired for solar data

D. PREFERENCES AND USES OF WIND DATA

The Global Atlas is also intended to provide a unified, high-resolution and public-domain global wind data set. Survey respondents were asked about their use of wind data.

1. Wind data currently used

Respondents were asked to list the sources they currently consult for wind data. The most common data source among all survey responses was NASA (also the most common data source for solar data). A sample of the most frequently listed data sources follows.

Wind Data Source ("Write-in" Responses)	No. of respondents
3Tier	4
AWEA/EWEA	3
IEA	3
NASA	5
NREL	3
Own research	4
National sources	5

Table 5. Sample of Most Frequently Listed Wind Data Sources Currently Used

2. General interest in wind data from the Global Atlas

When asked if they would use the wind data available from the Global Atlas, 55%of all survey respondents (and project developers) responded "yes."

3. Interest in specific wind parameters

Respondents were asked to rate the level of importance (ranging from "not important", which was given a score of "1" to "very important", which was given a score of "5") of specific wind parameters:

» Mean wind velocity

» Mean wind power density

» Wind speed distribution (given by, for example, Weibull A and k parameters)

» Wind speed distribution by direction sector (given by, for example, Weibull A and k parameters)

» Wind direction distribution (frequency and wind rose)

» Characteristics of diurnal cycle

» Characteristics of annual cycle

» Characteristics of extreme conditions

» Stability characteristics

» Time series data of wind velocity

» Elevation data in digital maps

» Roughness data in digital maps

Out of 101, nearly 50 of all survey respondents provided ratings, and approximately 15 out of 29 project developers provided ratings.

Results of the survey indicate that all of the parameters are relatively important. All were rated as either "quite important" or "very important" by over 60% of all survey respondents (and project developers). None of the parameters were rated as "not important" or "minimally important" by more than 15% of all survey respondents (or project developers).

a. Importance of wind data parameters to project developers

The full set of wind parameters and the project developers' ratings are displayed in Figure 8. The parameters that received the highest average ratings from the project developers were wind speed distribution, wind speed distribution by direction sector and mean wind velocity (all with a mean rating above 4.3). Two of the wind parameters, wind speed distribution and wind direction distribution, were rated as "very important [5]" by over 70% of the project developers that answered the question.

The survey did not provide criteria for distinguishing "very important" from "quite important", so it is also worth noting which parameters were most consistently given either of those two ratings. Figure 8 shows that all of the parameters listed were given a rating of "quite important [4]" or "very important [5]" by over 60% of project developers that answered the question. Four parameters were rated as either "quite important [4]" or "very important [5]" by at least 80% of project developers: wind speed distribution, uncertainty in data, time series data of wind velocity and mean wind velocity, followed closely by wind speed distribution by direction sector and wind direction distribution.

Only three parameters received ratings of "minimally important [2]" or "not important [1]" from more than 10% of project developers: wind direction distribution, characteristics of annual cycle and characteristics of extreme conditions.

To some extent, the level importance of wind parameters varies from one project developer to the next, for example:

- In wind direction distribution, which had the fourth-highest mean rating [4.29], nearly 80% of project developers rated this parameter as "quite important [4]" or "very important, [5]", yet it was also one of the two parameters that was rated "minimally important [2]" or "not important [1]" most often.
- In elevation data in digital maps, which had the sixth-highest mean rating [4.15], this was one of five parameters that over 60% project developers rated as "very important [5]", yet it was the only parameter that no project developer rated as "quite important [4]."

b. Importance of wind parameters according to all survey respondents

Consistent with the project developers' responses, nearly 70% of all survey respondents rated wind speed distribution as "very important [5]" and over 70 per cent

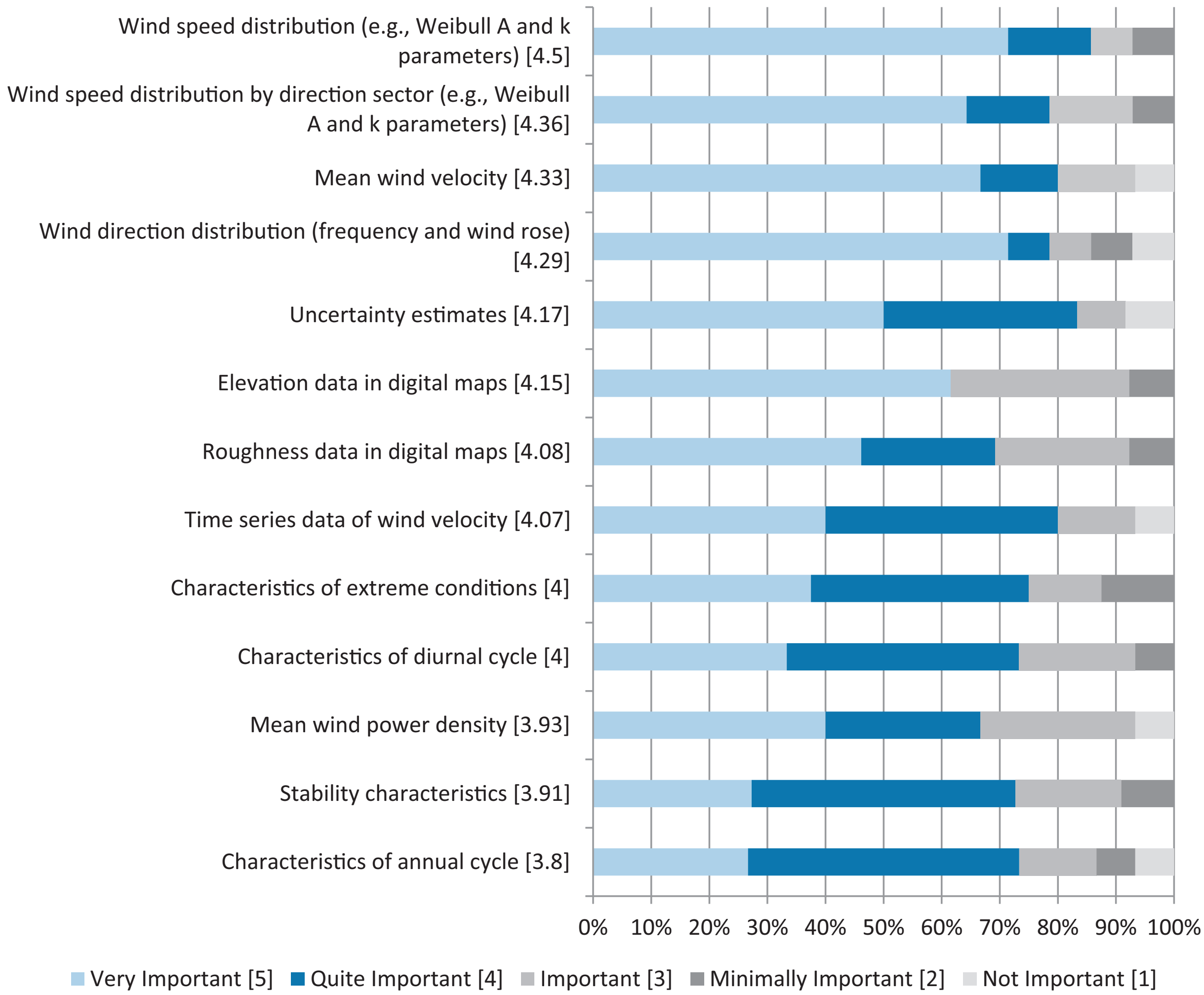


Figure 8. Project developers' responses: level of importance of specific wind parameters, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

rated mean wind velocity as "very important [5]." Distinct from the project developer subset, only about 50% of all survey respondents rated wind direction distribution as "very important [5]."

Relative to all the other wind parameters, the item involving characteristics of annual cycle was rated as least important, with a mean rating of 3.8.

c. Other important wind parameters not originally listed on survey

Survey respondents were asked to list if there were other parameters that they would have ranked between "important [3]" and "very important [5]" but there were no responses to that question, suggesting that the list of wind parameters provided in the survey was fairly comprehensive.

d. Temporal requirements for wind data

Survey respondents were asked to identify the highest temporal resolution relevant to their work. As shown in Figure 9, the responses clearly indicate the importance of wind data at a fine temporal scale – 57% of project developers selected hourly data and nearly 30% selected 10-minute data. No project developers selected annual or decadal data.

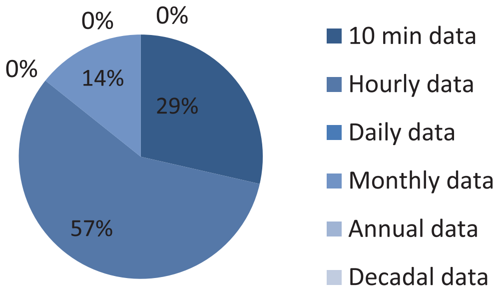


Figure 9. Project developers: temporal requirements for wind data

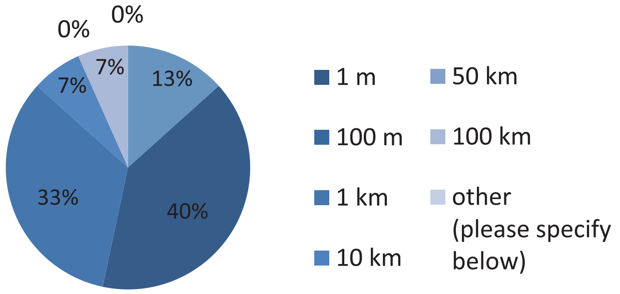


Figure 10. Project developers: spatial requirements for wind data

The responses of the all survey respondents were generally consistent with those of the project developers.

e. Spatial requirements for wind data

Survey respondents were asked to identify the highest spatial resolution relevant to their work. Nearly 75% of project developers that responded to the question indicated that the highest resolution data that they would need is either 1 km or 100 m. The responses of the all survey respondents were generally consistent with those of the project developers.

E. IMPORTANT INDICATORS AND OTHER RELEVANT DATA

In addition to solar and wind resource potentials, project developers and other users of the Global Atlas may be interested in data that characterises a region, such as energy, socio-economic and policy conditions. Between 70 and 80 of all survey respondents rated the importance of these types of data (between 20 and 30 of those ratings were from project developers).

1. Energy indicators

Respondents were asked to evaluate the importance (ranging from "not important", which was given a score of "1" to "very important", which was given a score of "5") of the following energy indicators:

» Electricity consumption (province)

» Electricity consumption per sector (country or state)

» Electricity consumption/GDP (country or state)

» Electrification rate (country or state)

» Electrification rate (province)

» Installed capacity of solar thermal energy

» Electricity: installed capacity of solar power plants

» Electricity: installed capacity of wind power plants

» Electricity: solar PV production

» Electricity: wind production

» Share of renewables (country or state)

» CO_2 emissions (country or state)

» Energy production (country or state)

» Electricity production (country or state)

» Energy imports and exports (percentage and costs)

» Energy prices (country or state level)

» Energy reliance (province)

» Infrastructure (electricity transmission and distribution lines)

As shown in Figure 11, all of these energy indicators were rated as "important [3]", "quite important [4]" or "very important [5]" by over 85% of project developers and as "quite important [4]" or "very important [5]" by at least 60% of project developers. The most important energy indicator was energy prices, which received a mean rating of 4.46 (country or state level). The two parameters with the next-highest mean ratings were infrastructure (transmission and distribution lines) and installed capacity of solar power plants.

As with many of the questions on the survey, even though a large portion (80%) of project developers rated share of renewable energies (country or state) as "very important [5]" or "quite important [4]", it was also the energy indicator that the largest fraction (over 10%) of project developers rated as "not important [1]." The responses to the survey did not reveal that any of the listed energy indicators were particularly "useless", but rather, different project developers have somewhat different data needs.

Survey respondents were also given the opportunity to list additional energy indicators that they would have rated as "important [3]," which received 20 responses (8

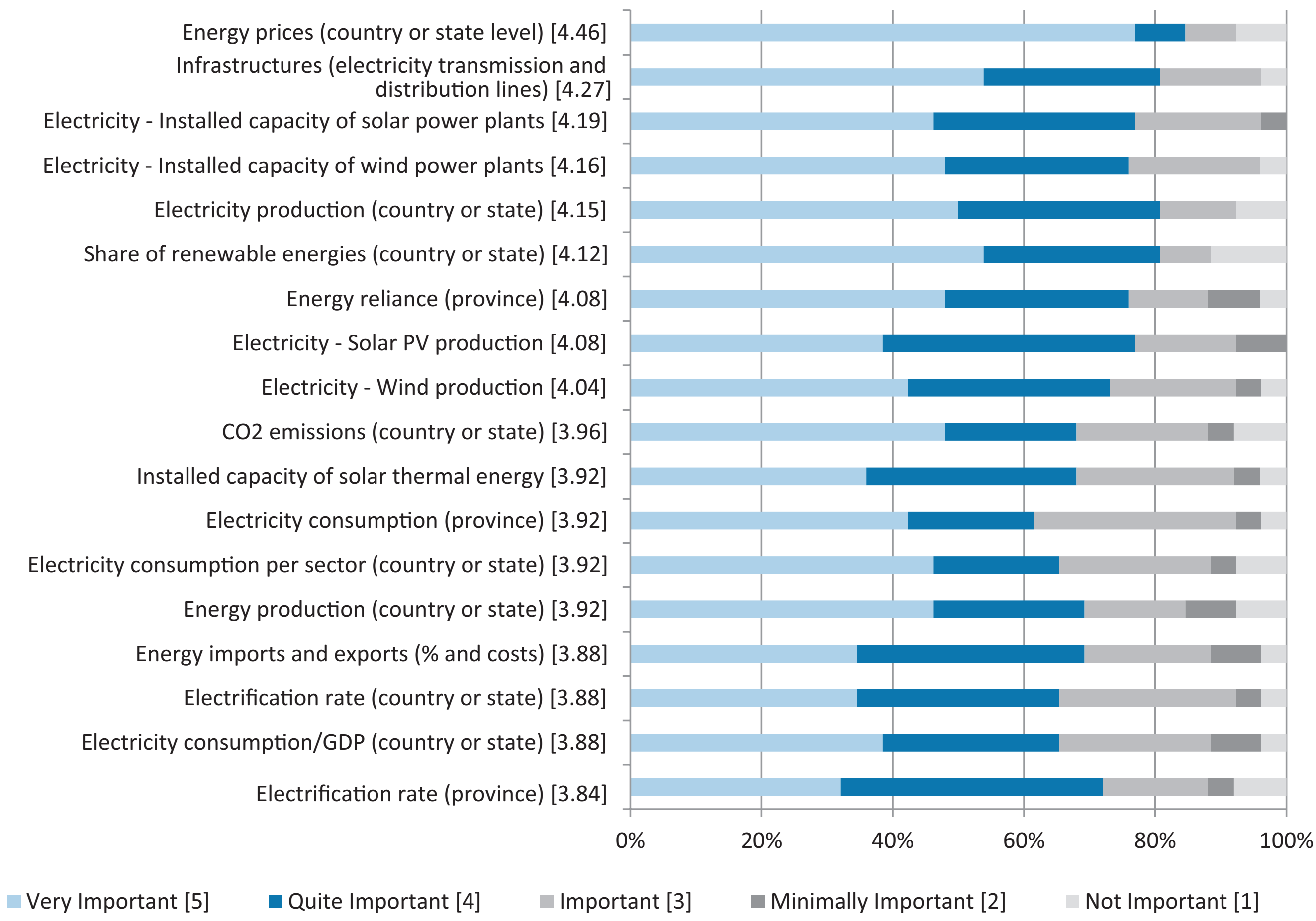


Figure 11. Project developers' responses: level of importance of energy indicators, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

were project developers). The only energy indicators that were suggested more than once were related to growth rates (or projections) of generation and growth rates (or projections) of consumption.

2. Policy indicators

Respondents were asked to evaluate the importance (ranging from "not important", which was given a score of "1", to "very important", which was given a score of "5") of the following policy indicators:

- Policies and support mechanisms
- Regulatory framework and approval processes
- Regulatory or administrative barriers
- Institutional framework/government agencies
- Important stakeholders
- Programmes or policy initiatives
- Energy market structures – ownership and competition
- Investment on renewable energies

As to the question regarding energy indicators, all of the policy indicators were rated as "very important [5]" or "quite important [4]" by over 60% of project developers (and received a rating of "important [3]" or higher by nearly 90% of respondents). The responses of project developers are summarised in Figure 12. The three policy indicators with the highest mean ratings –policies and support mechanisms, regulatory framework and approval processes, and regulatory or administrative barriers –were rated as "very important [5]" or "quite important [4]" by over 80% of project developers. This is consistent with the trends in responses from all respondents.

Although each policy indicator was rated as "not important [1]" by one or two project developers, none of the policy indicators stand out as notably less important as the others.

3. General and economic indicators

Respondents were asked to evaluate the importance (ranging from "not important", which was given a score of "1" to "very important", which was given a score of "5") of the following general and economic indicators:

- Population (country or state)
- Population (province)
- Population density (province)
- GDP (country or state)
- GDP by sectors (country or state)
- Poverty ratio USD 1 a day (country or province)
- Poverty ratio GNI (country or province)
- Aid: per cent of GNI (country)
- Foreign direct investment (country)
- Central government debt (country)
- Natural hazards (country or state)
- Infrastructure (roads and railways)

The responses of project developers are summarised in Figure 13. The most important general and economic indicators, which received the highest mean ratings and were the only indicators (in this category, rated as "very important [5]" or "quite important [4]" by at least 60% of project developers), are: natural hazards (country or state), population density (province) and infrastructure (roads and railways). However, all of the general and economic indicators received a rating of at least "important [3]" by all project developers.

As shown in Figure 13, five of the general and economic indicators were rated as "minimally important [2]" or "not important [1]" by over 20% of project developers:

- Aid: per cent of GNI
- Central government debt
- Poverty ratio USD 1 a day
- Poverty ratio GINI (country or province)
- GDP by sectors

The trends among all survey respondents are generally consistent with these trends among project developers.

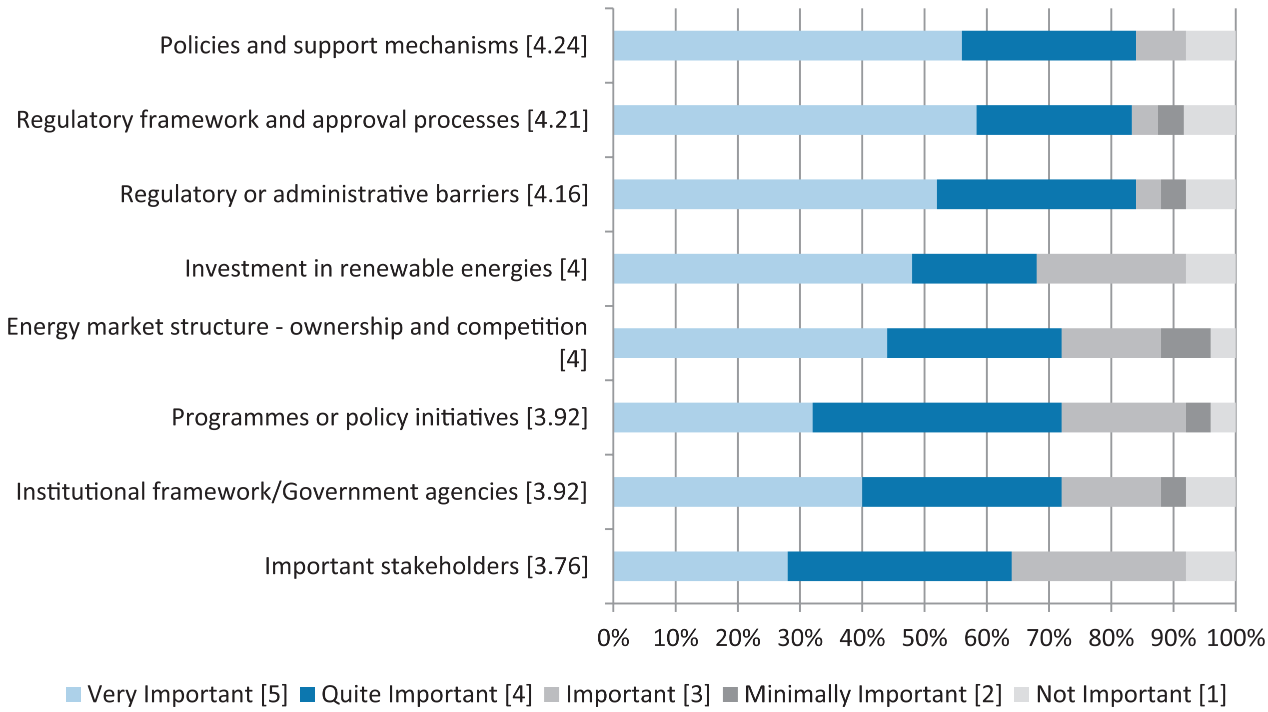


Figure 12. Project developers' responses: level of importance of policy indicators, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

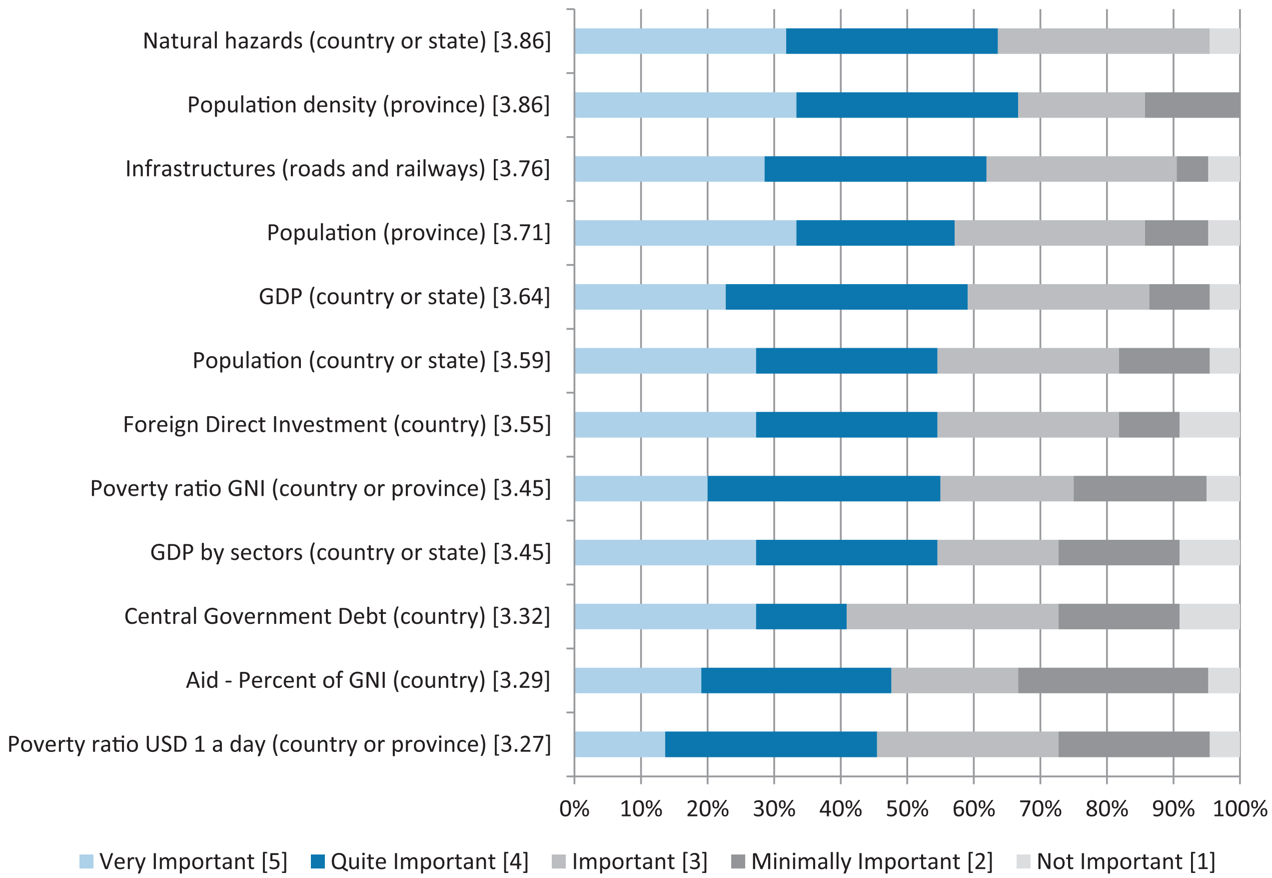


Figure 13. Project developers' responses: level of importance of general and economic indicators, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

4. Risk indicators

Respondents were asked to evaluate the importance (ranging from "not important", which was given a score of "1", to "very important", which was given a score of "5") of the following risk indicators (at the country level):

- Governance risk index (e.g. political stability, corruption)
- Security risk index (e.g. absence of violence, terrorism)
- Societal resilience index (e.g. coping with natural hazards)
- Disease risk index (e.g. prevalence of malaria, tuberculosis, etc.)
- Financial risk index (e.g. country credit rating)

Figure 14 summarises the importance of risk indicators according to project developers. The three most important risk indicators to project developers (and all survey respondents) are governance risk, financial risk and security risk index (all with a mean rating above 3.8).

5. Geospatial data: relevant map layers

Generating resource potential maps is one of several anticipated uses of data from the Global Atlas. Additional geospatial data may be needed, so users were asked to evaluate the importance of a variety of map layers, specifically:

- Terrain slope
- Horizon effect
- Protected areas
- Populated areas
- Water masses
- Infrastructure gas pipelines
- Infrastructure power lines and substations
- Infrastructure streets
- Geomorphology
- Land cover/land use

As shown in Figure 15, all of the map layers were given a rating of "important [3]", "quite important, [4]" or "very important [5]" by 70% of project developers who answered the question. The three most important map layers, all with a mean rating above 3.85, are: infrastructure power lines and substations, populated areas and protected areas. The trends in responses from across all survey respondents are generally consistent with these trends in response from project developers.

One notable exception is land cover/land use, which was rated "very important [5]" or "quite important [4]" by 80% of all survey respondents, whereas 20% of project developers rated that map layer as "minimally important [2]" or "not important [1]".

The map layer with the lowest mean rating was that of infrastructure gas pipelines (3.09), which was rated as "minimally important [2]" or "not important [1]" by 30% of project developers.

F. ACCESS TO AND USE OF THE GLOBAL ATLAS

Users were asked a series of questions about how they would prefer to access the Global Atlas and its data.

1. Online access to the data

As shown in Figure 16, while one-third of project developers would prefer the Global Atlas to be available online, the majority (63%) would prefer to be able to access the Global Atlas offline as well as online. This is consistent with the responses provided by all survey respondents.

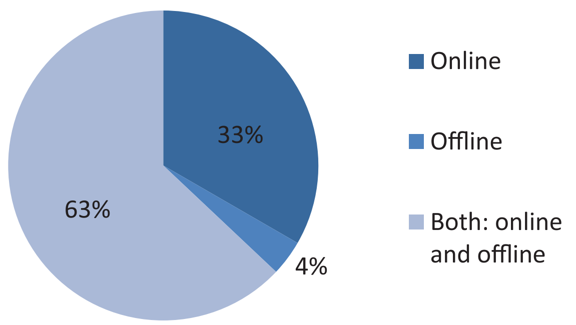


Figure 16. Project developers: importance of online and/or offline access to the Global Atlas

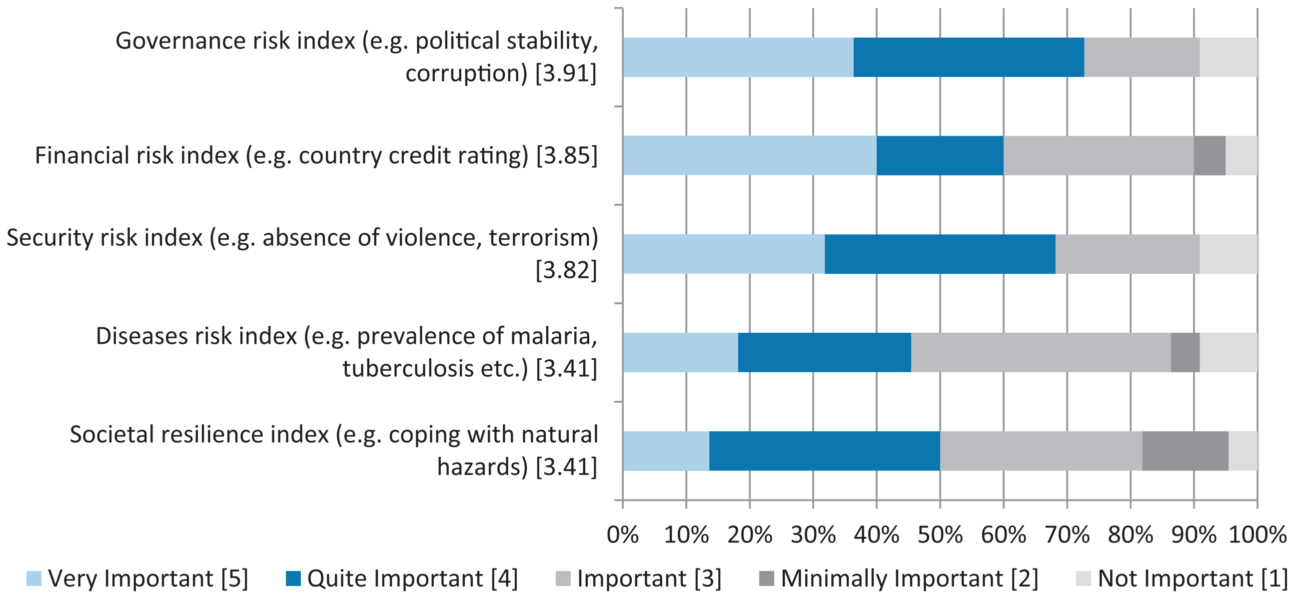


Figure 14. Project developers' responses: level of importance of risk indicators, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

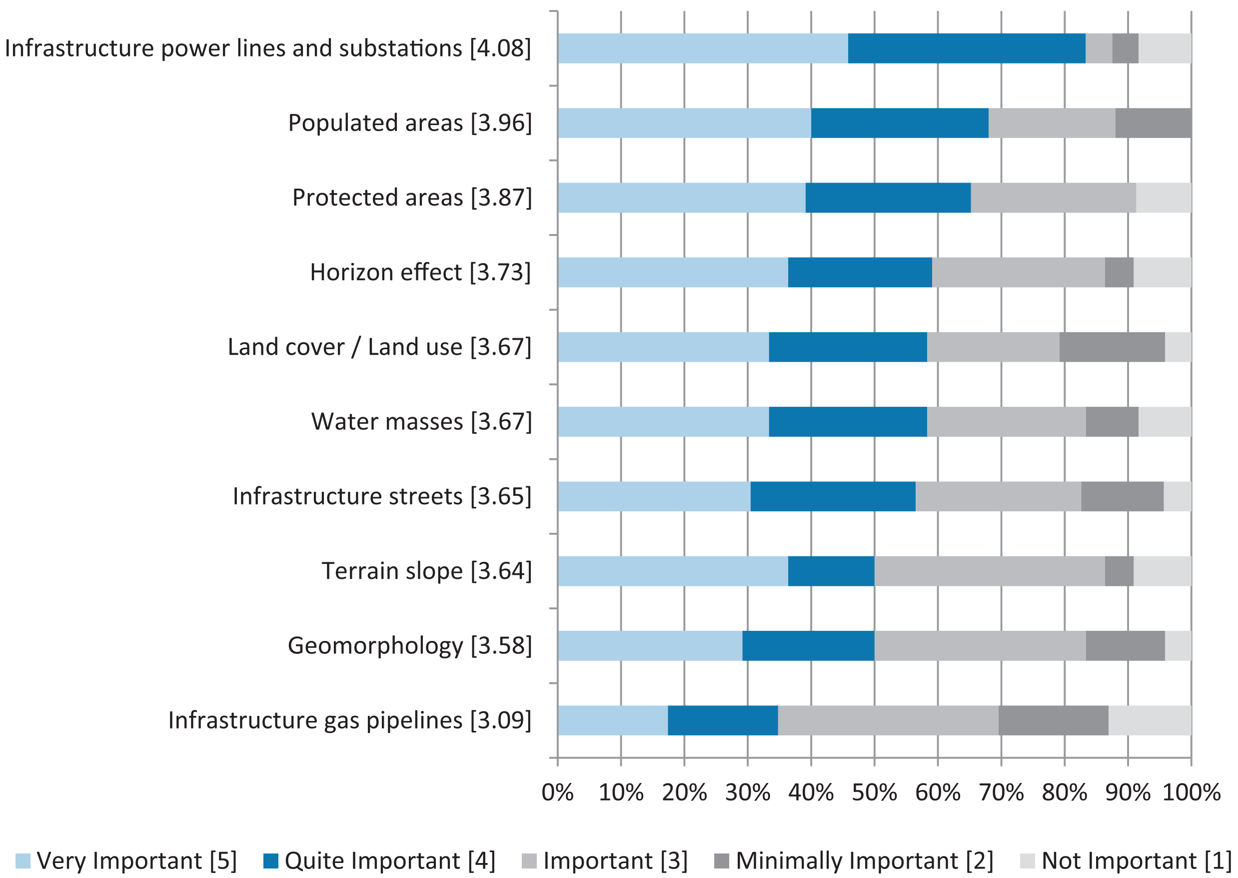


Figure 15. Project developers' responses: level of importance of map layers, listed from highest mean rating (top) to lowest mean rating (bottom); mean rating shown in square brackets

2. Geospatial preferences for selecting and downloading data

Users were asked about how they would download the Global Atlas data. Project developers are most likely to download the data by country, although they are also likely to download it by state, province or latitude/longitude. The responses of the project developers are shown in Figure 17; they are consistent with the responses of all survey respondents.

3. Preferred formats for downloading data

Users were asked which data formats they would prefer for downloading data from the Global Atlas. The most preferred format is Microsoft Excel. All responses from the project developers are shown in Figure 18; they are consistent with the respondents of all survey respondents.

4. Communicating and interacting with potential users of the Global Atlas

The survey included a few additional questions about the Global Atlas and the answers indicated that users would like to have a user-friendly product and that they would like to receive updates about it and receive training on how to use it. More specifically:

- Survey respondents provided additional input about the "ideal" Global Atlas, and the most frequently provided response was concerned with the site being easy to use/user-friendly.
- Over 80% of all survey respondents (and over 85% of project developers) said that they would be interested in training on the use of the Global Atlas and its data.
- Approximately 90% of all survey respondents (and project developers) said that they would like to be notified about future developments related to the Global Atlas.

G. SUMMARY OF IMPORTANCE OF ALL PARAMETERS

All survey respondents, as well as the subset of project developers (one of the primary audiences the project team would like to reach with the Global Atlas), rated most of the parameters listed in the survey as "important [3]", "quite important [4]", or "very important [5]". While it is useful to note that generally, any of the resource potential data or data on any of the energy, risk, policy or economic indicators are important to users, it is also helpful to identify those parameters that the survey respondents rated as most important.

Table 6 presents a summary of the top three most important parameters (the mean rating is shown in italics in the lower right corner of each cell in the table), as rated by all survey respondents (grey columns 2-5) as well as by just project developers (blue columns 4-6). For the most part, the responses of the project developers were consistent with those of all survey respondents.

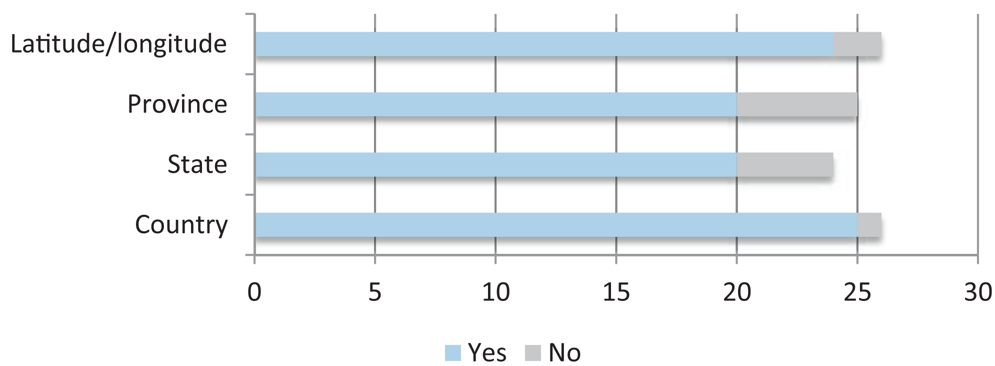


Figure 17. Project developers: preferences for downloading and accessing data

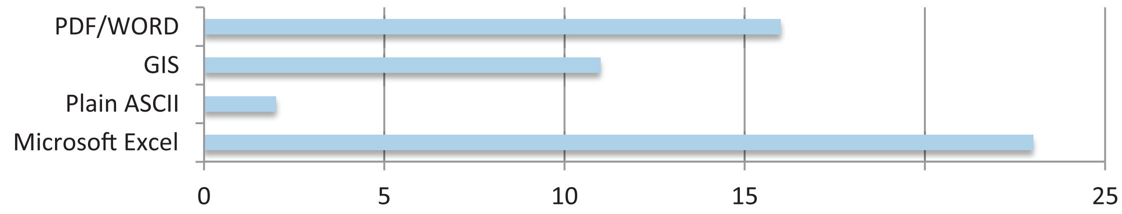


Figure 18. Project developers: preferred data format

Table 6. Comparison of survey results between all participants and project developers: three most important parameters (as defined by the mean rating); a rating of "5" is "very important" and a rating of "1" is "not important"

	All participants			Project developers		
	First	**Second**	**Third**	**First**	**Second**	**Third**
Solar parameters	Global Horizontal Irradiance	Direct Normal Irradiance	Uncertainty in the data on the above parameters	Global Horizontal Irradiance	Sunshine hours	Direct Normal Irradiance; Latitude Tilt Irradiance
mean	4.61	4.58	4.37	4.55	4.52	4.47
Wind parameters	Mean wind velocity	Wind speed distribution (given by for example Weibull A and k parameters)	Time series data of wind velocity	Wind speed distribution (given by for example Weibull A and k parameters)	Wind speed distribution by direction sector (given by for example Weibull A and k parameters)	Mean wind velocity
mean	4.58	4.53	4.35	4.50	4.36	4.33
Map layers	Populated areas	Protected areas	Infrastructure power lines and substations; Land cover / Land use	Infrastructure power lines and substations Land cover / Land use	Populated areas	Protected areas
mean	4.23	4.21	4.15	4.08	3.96	3.87
Energy indicators	Infrastructures (electricity transmission and distribution lines)	Energy prices (country or state level)	Electricity - Installed capacity of solar power plants	Energy prices (country or state level)	Electricity - Installed capacity of solar power plants	Electricity - Installed capacity of wind power plants
mean	4.44	4.42	4.33	4.46	4.19	4.16
Policy indicators	Policies and support mechanisms	Regulatory framework and approval processes	Regulatory or administrative barriers	Policies and support mechanisms	Regulatory framework and approval processes	Regulatory or administrative barriers mean
mean	4.25	4.22	4.20	4.24	4.21	4.16
General and economic indicators	Population density (province)	Natural hazards (country or state)	Infrastructures (roads and railways)	Population density (province)	Natural hazards (country or state)	Infrastructures (roads and railways)
mean	4.04	4.01	4.00	3.86	3.86	3.76
Risk indicators	-	Governance risk index (e.g. political stability, corruption)	Security risk index (e.g. absence of violence, terrorism)	Governance risk index (e.g. political stability, corruption)	Financial risk index (e.g. country credit rating)	Security risk index (e.g. absence of violence, terrorism)
mean	3.90	3.87	3.75	3.91	3.85	3.82

Concluding remarks

The purpose of the UNEP evaluation, which included interviews with researchers and project developers and the online survey, was to collect information about the data and analysis needs of individuals and organisations already involved with (or interested in) renewable energy development. Insights from the interviews and survey can help ensure that the Global Atlas provides useful data and tools. The survey results illustrated that the needs and opinions of project developers were, for the most part, representative of other types of end-users, including researchers, consultants and NGOs.

Generally, potential users of the Global Atlas would be interested in gaining access to almost any wind or solar resource data, as well as many energy and policy indicators, such as electricity prices and regulatory barriers. Also important are several general indicators (e.g. population density), risk indicators (e.g. political stability), electricity distribution network indicators (e.g. high-voltage lines and substations) and additional map layers (e.g. protected areas, water masses, and roads). Several solar parameters stood out as most important to project developers: sunshine hours, DNI, GHI and Latitude Tilted Irradiance. In addition, three wind parameters received the highest mean ratings: wind speed distribution, wind speed distribution by direction sector and mean wind velocity.

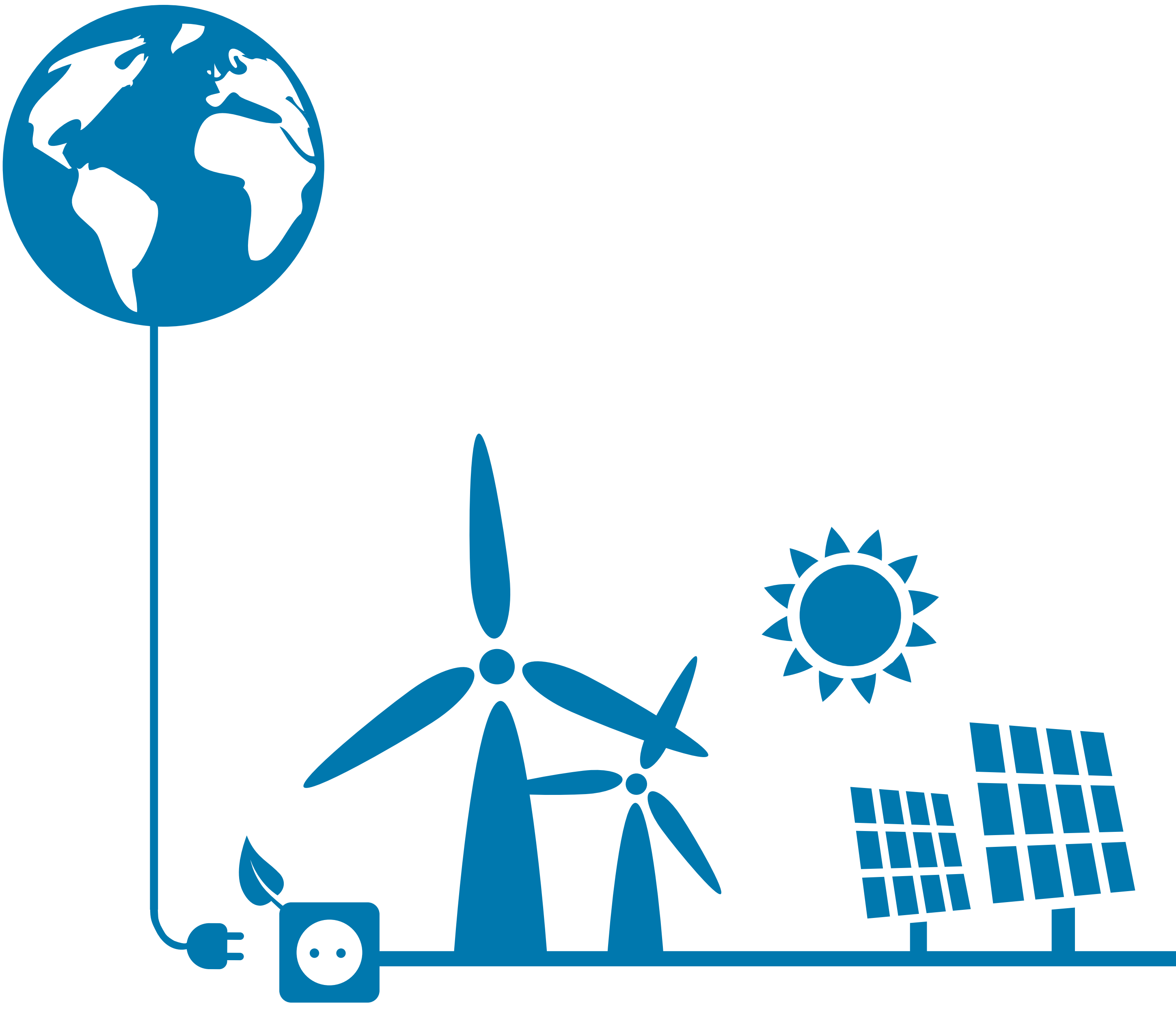
The spatial and temporal resolution of wind and solar data available from the Global Atlas will also be important. When asked to describe the highest spatial and temporal resolution data they would use (from a list of options), participants' responses trended toward the options with the highest resolution (e.g. hourly data for both wind and solar and 100 m grid cells for wind data).

It was clear from the interviewees and the survey respondents that different users have different needs and expectations, some of which will even be at direct odds. For example, some interviewees suggested that the Global Atlas only provide basic and essential data, while others suggested that it provide a wider range of data. Similarly, a single indicator (e.g. share of renewable energies) listed in the survey was rated as "very important" by a large portion of respondents, yet also rated as "not important" by a relatively large portion of respondents. Such differences in responses about desired depth of the Global Atlas database, data resolution and types of data highlight the fact that different end-users have different goals and different reasons for using the Global Atlas. For example, one person may be trying to understand if a local region would potentially be a good location for a generating power from wind or solar energy while a project developer may be trying to select the most productive site for a project will want different data and will plan to use the data in different ways.

Three key messages apparent from the interviews and confirmed by the survey are:

- » The Global Atlas data should be accessible both online and offline as many end-users work in remote locations with limited or no access to the Internet (or in places that have inconsistent Internet connections).
- » Users of the Global Atlas will want instructions for using the tools and about any uncertainties and limitations of the data. Further, they will expect explanations about how the data sets are created and the accuracy of and appropriate use of the data.
- » The Global Atlas tools and data will be valuable to end-users with different levels of expertise and analysis capabilities. The Global Atlas should be easy to use and provide advanced features for more sophisticated users. The Global Atlas should focus on providing high-quality, high-resolution wind and solar resource data for users to incorporate into their own models. It should also provide energy potential data that will allow less advanced users to obtain energy estimates a solar or wind installation could generate at a specified location.

These findings are complemented by the outcomes of a workshop on end-user expectations for the Global Atlas, which is documented in the appendix on the following pages.



Appendix

Global Solar and Wind Atlas Gathering the end-user community

January 13th, 2012. Abu Dhabi

IRENA
International Renewable Energy Agency

In partnership with: CLEAN ENERGY MINISTERIAL Accelerating the Transition to Clean Energy Technologies

SUMMARY

BACKGROUND AND PROCESS

In partnership with the Clean Energy Ministerial Multilateral Solar and Wind Working Group, IRENA is coordinating the development of the Global Solar and Wind Atlas[1].

The activity should make accessible the most recent knowledge, and develop instruments to help identify the potential of different renewable technologies and their most suitable locations, with the following perspectives:

» For governments, an accurate knowledge of renewable energy potentials helps conciliating renewable energy deployment with other human activities and environmental protection, to plan the necessary infrastructures, to put in place market incentives, and the necessary policies to eventually develop and implement their national energy strategy.

» In turn, transparent planning and policies at the governmental level can provide investors and the renewable energy industry with confidence in their own investments and undertakings, which enhances market certainty, lowers the investment risks, and supports and eases access to capital. The private sector would also benefit from accurate data on a country or region's renewable energy potential, in order to prospect new markets or propose new solutions.

» The investment timelines in the energy sector are of the order of decades, and the transition of a country's energy mix and energy system requires long-term planning over time (30 to 50 years). Planning investment and successfully transition requires an accurate knowledge of the renewable energy potential, to develop energy scenarios and strategies.

IRENA's objective is to ensure the Global Solar and Wind atlas initiative fits the needs of the end-user community. To this end, this working session had three objectives:

» Informing on the latest developments of the Global Solar and Wind Atlas,

» Based on preliminary assessments of the end-user needs, working with the audience on the data and services required to make the future system most useful,

» Strengthening the involvement of experts and representatives of Member countries in developing the Global Solar and Wind Atlas.

Part of the workshop was organized in round tables, to collect the views of the participants on two major topics:

[1] Under the Knowledge Management section of IRENA's work programme, Solar and wind are studied as pilots towards the assessment of potentials for all renewable energy resources.

» Topic 1: Characteristics of the Atlas to promote renewable energy policy-making and attracting renewable energy investments

» Topic 2: Capacity-building activities

The participants were seated at round tables of 10 persons. Each table focused on one topic, either Topic 1 or Topic 2. Each table had 45 mn to develop its main recommendations, using a questionnaire as a guidance document. The questionnaire was designed in partnership with:

UNEP

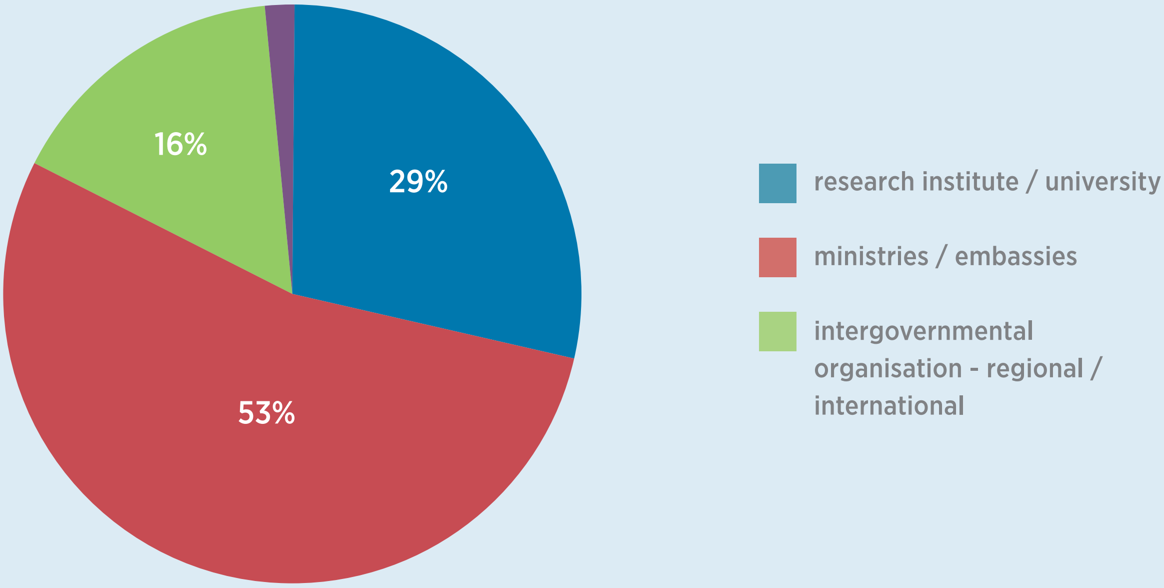
REN21 Renewable Energy Policy Network for the 21st Century

NREL National Renewable Energy Laboratory *Innovation for Our Energy Future*

ATTENDANCE

63 participants attended the event. Three major categories of end-users were represented: civil servants from ministries or embassies (53%); research institutes and universities (29%); and intergovernmental organizations at regional or international level (16%).

This first meeting of the end-user community targeted the governments and governmental entities. At this session, organized back to back with the IRENA Assembly, the private sector is therefore under-represented.



NEXT STEPS

IRENA intends to progressively mobilise the end-user community on the Atlas, and maintain a continuous structured dialogue on the developments. This dialogue should enable to gather end-user expectations, possible partnerships with existing programmes or projects, identify areas of improvement, and update the community on progresses.

This dialogue complements the work of IRENA and its partners for further expanding the partnership on the Atlas. The intention is to use the list of participants to the workshop to initiate this dialogue. The list would progressively be expanded to build a large end-user community, actively contributing to the developments.

The end-user workshop brought forward a number of recommendations detailed in the next section. These recommendations will be taken into account by a comprehensive study currently carried out in partnership with UNEP, which combines different end-user analyses: the experience gathered through the SWERA programme; the result of an online survey; and the analysis performed by the Solar-Mediterranean atlas project.

MAIN OUTCOMES

The text below summarizes the outputs of the questionnaires collected from each of the six tables, and encapsulates the main recommendations.

General expectations on the Global Solar and Wind Atlas

The Global Solar and Wind atlas (the Atlas) should perform an initial analysis of the renewable energy potentials, and highlight the technical opportunities at different geographic scales (country, region), with a consistent and systematic approach.

This initial analysis might highlight areas of particular interests, and provide a simple ranking of those areas, based on a number of simple and transparent parameters. The information should be sufficiently credible to attract interest from decision-makers, and generate financing for ground measurement campaigns and detailed assessments. Ground measurement campaigns will be mandatory to refine and validate the initial analysis performed by the Atlas.

Importance of the partnership and political momentum

The credibility of the initiative will rely heavily on the expertise of the technical consortium, the support of the participating governments, and the outreach activities from the involved governments and international organizations.

Data quality and implementation strategy

The information contained within the atlas should be peer-reviewed, high resolution, accurate, validated through state-of-the-art methodologies, documented, updated, and should provide information on the data quality and the uncertainty of the information. The documentation should detail the added-value of the initiative, as well as its limits. In addition to the information on the resource, additional physical elements should be included (sand, dust), as well as the additional information necessary to evaluate technical potentials.

The initiative should be implemented gradually, starting with the available information, and improved along time. It should build on existing initiatives and partnerships and avoid duplication, but should avoid displaying information which does not satisfy minimum quality requirements. Those quality requirements are to be defined.

The inclusion of national or regional atlases is important, as it can generate a higher level of cooperation and coordination, and provide a common reference for joined initiatives. Mobilizing the national and regional entities might require an additional effort. Commercial data providers might as well be willing to share part of their data portfolio.

Data access and data management

The information should be provided through a user-friendly online interface, along with a detailed user manual. Access to the information is critical, especially for areas with limited access to the internet. For such cases, information should be made available on CD or be downloadable for further processing. Providing such offline access however poses the question of intellectual property management and liability for the analyses performed offline by third parties. This needs to be carefully considered. The ability to deliver the information in several languages will be a critical element to maximize the outreach.

Online tools and services requiring local information

Simple tools would be helpful to provide a basis for decision-making for governments. Such tools could for instance assess technical potentials, provide information of a possible energy mix for a country, provide data on CO2 emissions, evaluate the potential for rural electrification, and job opportunities. Their outputs could also be used to initiate policy development and planning at national and local level, involving the communities. Most of the information required for such purposes requires country-specific information.

The audience insisted on the need to include country-specific information to the Atlas, which cannot be developed outside of the developments happening at regional and national level. Information such as grid development, rural electrification or energy access plans/schemes already available in countries could be overlaid with wind and solar atlases[2].

Additional end-users

Investors, developers and utilities might find an interest in the system, if it can be used to initiate pre-feasibility studies of large installations, and help feasibility studies for small-scale projects[3]. This would require including information on national policies and legal frameworks, market conditions, custom tariffs, or infrastructure situation. It must be made clear however, that the Atlas cannot be used for final investment decisions, but shall be seen as a prospection tool.

Additionally, energy agencies, local communities, consultants, NGOs and academics could use the information for various purposes, including raising awareness on technology opportunities within a country and educational purposes.

Building capacity

The Atlas should act as an entry portal for assessing renewable potentials, and provide information for a detailed evaluation of the resource: methods, tools, and recommendations, information on technologies, expert contacts and case studies.

A clear methodology is necessary to guide the end users through the process of evaluating the resource, and collecting the additional information needed to derive technical, and possibly economic potentials. Looking forward, the Atlas should as well explain the process to move forward from the evaluation of the technical opportunities to open the dialogue on policy developments.

In this respect, capacity building on resource assessment, evaluation of energy potentials, and making use of this information for policy making and project development, illustrated by past experiences and case studies is crucially needed.

Although the recipients of capacity building activities will vary, universities, and regional entities were mentioned as key partners for the Atlas. The outcomes of the capacity building activities should raise awareness among decision-makers to facilitate political buy-in, help learning from others' experience, and help learning by doing – in partnership with the regional centers.

For developers, a database providing an overview of the availability of local knowledge/skills (e.g. engineering/ university graduation statistics, data from professional organizations such as number of individual and enterprise members), or data on local manufacturers would be beneficial while performing a first market screening. The upcoming IRENA Renewable Energy Learning Partnership (IRELP) could provide a valuable contribution in this respect.

Expanding the concept

Finally, the audience recommended replicating the initiative to the other renewable energy resources.

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[2] Examples include: Zambia grid development, Rwanda energy access plan (which includes "market" data such as village electricity demand, willingness to pay, disposable income for electricity).

[3] The example of RetScreen was mentioned by several groups.

Annex: Topic description and questionnaires

TOPIC 1: CHARACTERISTICS OF THE GLOBAL ATLAS REQUIRED TO PROMOTE RENEWABLE ENERGY POLICY-MAKING AND ATTRACT RENEWABLE ENERGY INVESTMENTS

Round table description

An energy system based on a high share of wind and solar energy resources needs to harvest solar radiation and wind when and where they are available. This requires factoring for different uses of the available space, be it on land or at sea. Spatial planning instruments help to identify the potential of different renewable technologies and their most suitable locations.

The investment timelines in the energy sector are of the order of decades, and the transition of a country's energy mix and energy system requires long-term planning over time (30 to 50 years). To be able to thusly plan investment and successfully transition requires an accurate knowledge of the renewable energy potential.

Combining planning strategies over space and over time in this way enables to define 'where' and 'when' a specific renewable energy source can be deployed.

For governments, such approach enables to conciliate renewable energy deployment with other human activities and environmental protection, to plan the necessary infrastructures, to put in place market incentives, and the necessary policies to eventually develop and implement their national energy strategy.

In turn, transparent planning and policies at the governmental level can provide investors and the renewable energy industry with confidence in their own investments and undertakings. That then enhances market certainty, lowers the investment risks, and supports and eases access to capital. The private sector would also benefit from accurate data on a country or region's renewable energy potential, in order to prospect new markets or propose new solutions.

The value of the Solar and Wind Atlas as a global decision-making instrument is immense; it can direct and enhance cooperation on global scenarios and strategies. At a continental level, energy systems like electricity grids are interconnected or inter-related, and an accurate picture of resources is required for political coordination. The same is true at national, regional and local level. Each geographic scale requires a different data interpretation and a different approach.

This session aims at collecting the experiences and recommendations from the audience, in order to maximise the added-value of the Global solar and Wind Atlas, for policy-makers, investors, and project developers.

Questions

- What are your expectations from the Global Solar and Wind Atlas? *e.g. expectations in terms of data quality, online tools, resources*

Part 1: Supporting policy-making

- In your experience, on which step of the policy-making processes do atlases and spatial planning instruments best support the development of energy plans and policies?
- What type of information is the most valuable for this purpose, under which format? *e.g. possible energy production, avoided CO2, environmental impacts, potential for rural electrification*
- Can simple tools for estimating energy potentials help in interpreting the information and raising the political momentum? *e.g. identifying hotspots, using simple cash flow models, job creation simulators or CO2 avoidance simulators*
- Which elements would help providing sufficient confidence in the Atlas for helping the development of policies promoting renewables?
- Under which conditions would the Global Atlas help in initiating the deployment of measurement campaigns at national scale?

Part 2: Increasing awareness and interest from project developers and investors

- How best can the Atlas attract the interest of renewable energy developers and investors in new markets?
- What type of information would help developers and investors to invest in detailed assessments within areas of high potential? *e.g. information on electricity market structure, indications of long-terms policy support for renewable energy, indications on existing policies and regulations*
- How best can the information be presented and handled for practical purposes?
- Which online features would be necessary? *e.g. basic spatial planning tools, such as tools to measure the distance between a high potential area and transmission lines, populated areas, natural reserves, online tools to estimate the cost/benefits of investments*

Part 3: Other user categories

- What role would you see for the Global Atlas in addressing other categories of end-users? *e.g. academia, education, general public*
- What type of information is the most valuable for this purpose, under which format?

Part 4: Integrating existing work

- Would you recommend specific existing works to be integrated within this initiative?
- Is the inclusion of existing national / regional atlases relevant? If so, under which conditions would such collaboration be the most effective?
- Please mention any other point of interest you wish to highlight

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UNEP is supporting several international partners in the development of a platform for sharing a global, public domain dataset that includes information on renewable energy resource potentials as well as relevant socioeconomic and policy information. The purpose of the platform, called the Global Atlas for Solar and Wind Energy (Global Atlas), is to facilitate the deployment of renewable energy technologies by providing access to relevant data. The overall project is coordinated by IRENA.

To ensure that the Global Atlas will be a useful resource, UNEP interviewed a subset of users of a similar UNEP tool, the Solar and Wind Energy Resource Assessment (SWERA), and invited potential end-users to complete an on-line survey about their general data needs between late 2011 and early 2012. These results are described in the publication. They are complemented by the outcomes of a workshop on end-user expectations regarding the Global Atlas.

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