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Global Atlas for Renewable Energy – Geothermal Component

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ABSTRACT

The International Renewable Energy Agency (IRENA), has launched a Global Atlas for Renewable Energy (Global Atlas) with a component focused on geothermal energy. The Global Atlas is an online Geographic Information System (GIS) linked to a large number of data centers located around the world. It is freely accessible and allows users to visualize information on renewable energy resources worldwide.

Currently, several initiatives exist within the community that collect geothermal data. However, the focus areas of these initiatives are often streamlined either to a specific kind of geothermal system (EGS, Hydrothermal etc.), a specific topic (Policies, Installed plants), or geographical coverage (national, region etc.).

Equally for resource mapping, a number of different protocols have been used, even across the various geothermal systems that exist[1]. In this, there is also not a single reporting code common to all countries for relating the resource estimates that result from these mapping processes.

The consequence being that there is an overrated perception of risk and a lack of proper recognition of the possible contribution of geothermal energy in its many forms (electricity, direct use, heating and cooling) to the energy mix of countries.

The Global Atlas brings added value to the geothermal sector by acting as a central repository for geothermal related information across all the relevant systems that exist globally. The Global Atlas includes resource maps[2], policies, capacity building opportunities, conferences proceedings and information on active geothermal environments[3].

It is envisaged that the geothermal component of the Global Atlas could act as: a tool to aid political discussions on the subject; an entry point for investors' preliminary search for prospective areas of the world; and also a tool to support further massive ongoing effort by the geothermal community to compare and harmonize assessment protocols and reporting codes for geothermal energy.

The strategy for the geothermal component of the Global Atlas is the outcome of a detailed consultation process with the geothermal community, which involved experts, research institutes, private companies, and international agencies working on the subject.

This paper will detail the data infrastructure of the Global Atlas, and the strategy towards the development of the geothermal component.

1. INTRODUCTION

Currently, there is no single information source for existing geothermal energy data. Several initiatives exist within the geothermal community[4] that collect geothermal data, but these often use widely different methodologies.

Equally for resource mapping, a number of different protocols have been used for such assessments, even across the various geothermal systems that exist. There is also not a single reporting code common to all countries for relating the resource estimates that result from these mapping efforts.

The consequence of these are an overrated perception of risk in the sector and a lack of proper recognition of the possible contribution of geothermal energy to the different constituents (electricity, direct use, heating and cooling) of the energy requirements in countries.

In a detailed consultation conducted by the International Renewable Energy Agency (IRENA), the geothermal community identified as a first step, the need to create a large global repository for geothermal energy. The repository would contain available information in all the different aspects pertinent to geothermal energy including resource maps, policies, capacity building opportunities, conferences proceedings and active markets.

In response, the agency has aligned this need to an ongoing effort to develop a Global Atlas for Renewable Energy (Global Atlas). The Global Atlas is a Geographic Information System (GIS) linked to a large number of data centers all over the world and freely accessible over the internet. It features a catalog of datasets shared from these data centers, and a map viewer. The data catalog

[1] Enhanced Geothermal Systems (EGS), Hydrothermal Systems, Geo-pressured and Supercritical Geothermal systems
[2] Map of temperature at depth (EGS), Identified hydrothermal fields,
[3] Surface manifestations: thermal springs, fault maps, bouger gravity anomaly maps etc.
[4] Exploration geologists and researchers, developers, policy makers, investors

currently features over 1000 datasets covering mostly solar and wind resources and the map viewer allows users to search into this catalog and display relevant datasets in the form of maps.

The map viewer is equipped with several technical features that allow users to overlay and manipulate these datasets (resource maps, transmission grids, population centers, protected areas, topography etc., usually from different sources across the world, and to perform basic analysis aimed at identifying high opportunity areas, best suited for further investigation and possible development of renewable energy.

The Global Atlas is a product of a large international partnership comprising 67 countries, over 50 research institutes and several private companies across the globe http://globalatlas.irena.org/Partnership.aspx. The partnership and development of the product is coordinated by IRENA.

For geothermal energy – IRENA continues to work in partnership with the geothermal community to build a component in the Global Atlas focused on the sector. It is envisaged that the geothermal component of the Global Atlas could act as: a tool to aid political discussions on the subject; an entry point for investors' preliminary search for prospective areas of the world; and also a tool to support further massive efforts that could be undertaken by the geothermal community in the future to compare and harmonize assessment protocols and reporting codes.

The first chapter of this paper explains in detail the architecture of the Global Atlas data infrastructure with a specific focus on the capabilities to accumulate and disseminate thematic information across a wide range of forums. The second chapter explains the geothermal energy component, the strategy for its development, and highlights a number of geothermal and related datasets already being disseminated through the system.

Finally in the third chapter, we discuss in detail the added value of a Global Atlas focused on geothermal energy.

2. GLOBAL ATLAS INFRASTRUCTURE – SYSTEM ARCHITECHTURE

The architecture of the Global Atlas features two major constituents; the internet based GIS map viewer and the data catalog. The map viewer is a flexible and interactive interface with the primary capability to support visualization of data mostly in the form of maps.

The variety of data displays in the map viewer of the Global Atlas differs widely, ranging from raster datasets (e.g. solar, wind and temperature gradient maps) to vectors data such as points, lines and polygons (e.g. measurement masts, transmission lines, and protected areas etc.).

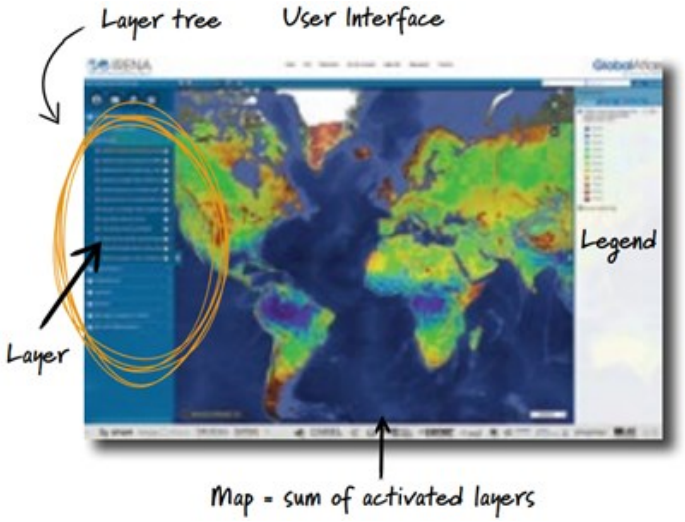


Figure 1: GIS map viewer for the Global Atlas for Renewable Energy.

The interface is also fitted with several capabilities and tools such as; the overlay, zoom and pan capabilities, a basic measurement toolset, an adaptable legend and the capability to easily adjust colour schemes and organize different data layers to produce high quality visuals of the resource and areas of high opportunity.

For advanced users, the map viewer includes a number of tools that enable simple calculations using these datasets. This aspect, as well as the general ergonomics of the entire interface is continuously being improved by IRENA with the support of the consortium of international institutes working on the project.

The data catalog on the other hand acts as the central support system of the Global Atlas. Technically, the catalog is a library of metadata (or dataset description) for the over 1000 datasets referenced in the Global Atlas. For each dataset, the metadata includes details about the source of the dataset, an abstract, the contact persons for the dataset, and most importantly the Web Map Service (WMS) or Web Feature (WFS) for this dataset.

The catalog is programed using standards set by the Open Geospatial Consortium (OGC) and as such is enabled with the capability to harvest content (metadata) periodically from remote data centers (geoservers) all over the world. The metadata harvested (and in particular, the WMS or WFS) are then stored in the catalog and served to the map viewer upon user request.

Figure 2: Data catalog for the Global Atlas for Renewable Energy.

Using these services (WMS, WFS), the map viewer interacts directly with these remote servers and is able to display as maps, the datasets shared from the servers. The advantage of such a system is that data providers have complete control over their datasets and how the datasets are shared. Also updates to the datasets are captured instantaneously by the platform since the datasets are not hosted locally but only accessed using the WMS or WFS.

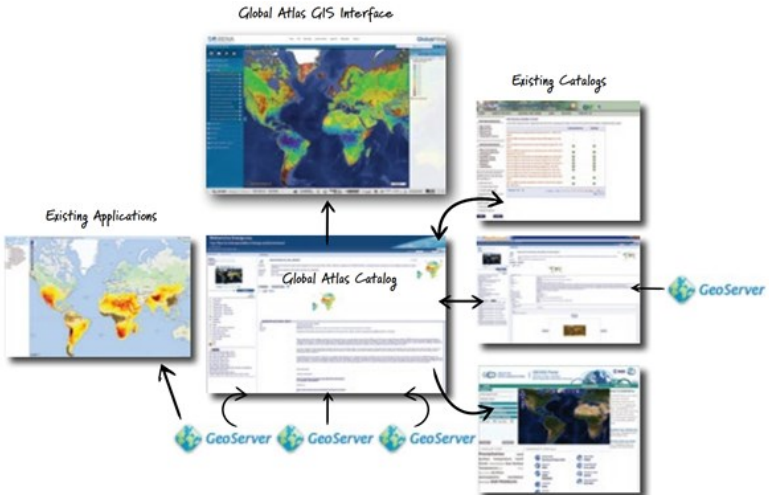


Figure 3: Data catalog for the Global Atlas for Renewable Energy.

The catalog is also able to interact with a large number of other data catalogs from similar initiatives that have been programed using the OGC standards (e.g. Onegeology, UNEPLive, GeoSUR). These catalogs are able to supply and harvest information (metadata) directly from the Global Atlas catalog.

The implication of this technical capability is that datasets registered in the Global Atlas catalog are visible to a broad audience transcending the energy and environment sectors. Also, users of the Global Atlas are able to access datasets from other thematic catalogs relevant to their mapping projects.

3. GEOTHERMAL COMPONENT

One of the major outcomes of IRENA's large consultation[5] with relevant experts, institutes, networks and private sector players in the geothermal sector, was a comprehensive list of available and relevant geothermal datasets[6] that could form the building blocks of a geothermal component in the Global Atlas for Renewable Energy.

[5] Initial desktop study, followed by two workshops at the European Geothermal Energy Conference in Pisa (June, 2013) and the Geothermal Resources Council Annual meeting in Nevada (September, 2013)
[6] ANNEX 1: http://globalatlas.irena.org/UserFiles/Publication/GA_Geothermal_Web.pdf

The agency has in response built a single integrated platform designed to disseminate these datasets as a component of the Global Atlas. A very notable feature of this platform is a Resource Selector (Shown on the left of figure 4), which enables to filter the content of the entire web platform by resource.

Figure 4: Geothermal component.

Other major futures of the new platform include the map gallery (1) and the learning center (3). Users who select the "geothermal" option in the Resource Selector are able to see only geothermal related content in the map gallery, learning center and publications.

3.1 Map Gallery

The gallery is the link to the GIS map viewer. For geothermal energy, the map gallery displays geothermal thumbnails of several resource maps and related information presented in map format (raster and vectors). These include temperature gradient maps, geothermal plants and locations, point based heat-flow data.

Figure 5: Process of interaction between the Map gallery and the GIS map viewer of the Global Atlas.

Users are able to see the title and description for each map, and most to open the map in the in the GIS map viewer using the "launch map" button. The map gallery is also equipped with a search tool to enable a search for any geothermal map using related keyword. Figure 5 shows the process of interaction between the map gallery and the GIS map viewer and Figure 6 highlights some resource maps already available in the system and visible in the gallery and the GIS map viewer of the Global Atlas.

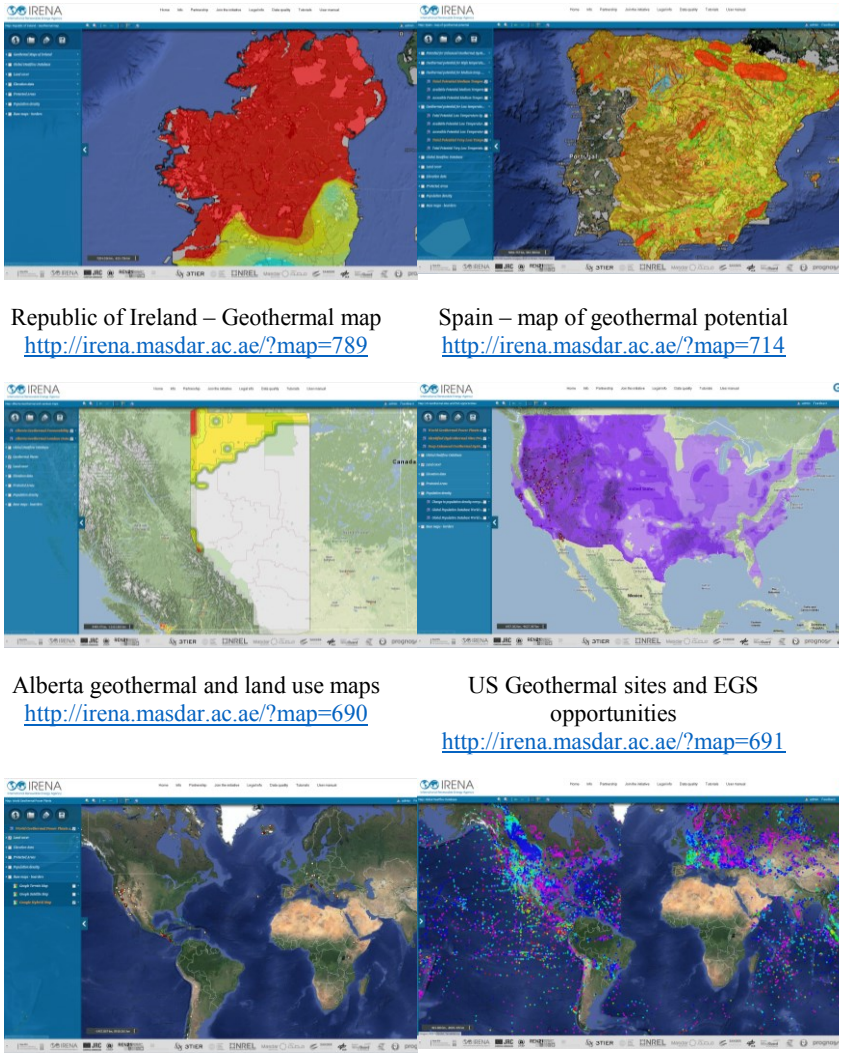
3.2 Learning Center

The Learning Center provides access to geothermal conference proceedings, training courses, and case studies where geothermal resource assessments in certain countries have been used in policy discussions. This section of the system is continuously being improved. The aim is to furnish the learning center with the latest information available.

4. ADDED VALUE OF A GLOBAL ATLAS FOCUSED ON GEOTHERMAL ENERGY

Having explained in earlier sections, the geothermal component of the Global Atlas for Renewable Energy; its architecture and constituents, in this section of the paper we discuss four specific value propositions for developing such a platform focused on geothermal energy.

4.1 Widespread Dissemination of Datasets



Republic of Ireland – Geothermal map
http://irena.masdar.ac.ae/?map=789

Spain – map of geothermal potential
http://irena.masdar.ac.ae/?map=714

Alberta geothermal and land use maps
http://irena.masdar.ac.ae/?map=690

US Geothermal sites and EGS opportunities
http://irena.masdar.ac.ae/?map=691

World Geothermal Plants
http://irena.masdar.ac.ae/?map=689

Global Heat flow database
http://irena.masdar.ac.ae/?map=689

Figure 6: Maps in the geothermal component of the Global Atlas for Renewable Energy.

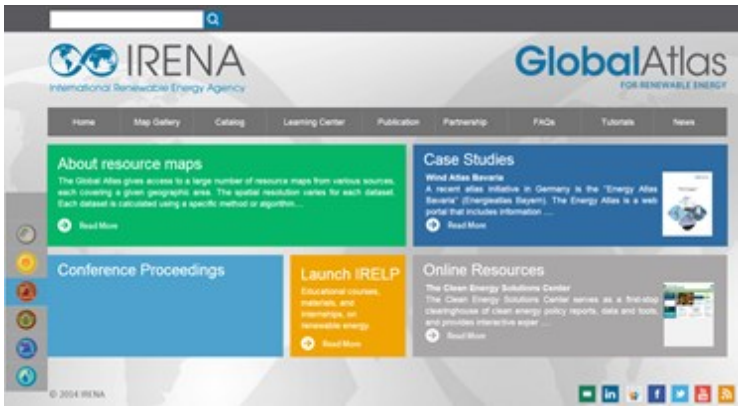


Figure 7: Learning Center.

A notable peculiarity in the geothermal sector is the dearth of publically accessible information. Even though significant amount of data (specifically on the resource) have been created overtime in many parts of the world, the information remains proprietary and hardly accessible due to the prevalence of contractual agreements with specific non-disclosure clauses.

Primary proponents and beneficiaries of such contractual clauses; funding institutions and exploration companies base their arguments around the need to protect their interests and that of their investors' in landed properties with identified geothermal potential. These arguments, though logical limit by a considerable margin, the amount of information available to public decision makers and other key sector players to create the right policies, support schemes and markets for geothermal energy.

We expect that this component of the Global Atlas, by showing examples of shared information and their impacts, would contribute immensely to stimulating discussion around the possible establishment of a level of public disclosure permissible for datasets generated within the geothermal community.

4.2 Contribution to Political Discussions Focused on Energy

The process of target setting, policy development and market creation in many countries starts with knowledge of the resources present and their location. By providing access to information on geothermal energy, the Global Atlas would serve as a stop point for a quick assessment of the opportunity areas for the further exploration of the resource and an inventory of existing effort (e.g. drillings, geochemical studies etc.) within countries that may be relevant in the preliminary mapping of the resource.

4.3 Standardization of Reporting Formats

A critical step in the commoditization and market liberalization of several minerals and fossil reserves has been the development of common standards to quantify and report estimates of these resources. The most important advantage of standardization in this context is that it established a firm basis to trade these resources as commodities. Standardization also helps to build a complete and consistent picture of the future supply base for fossil and minerals, which is a necessary prerequisite to effective resource management (UNECE, 2010).

For geothermal energy however, there are still no globally accepted standards for quantifying nor reporting resource estimates. As opposed to fossils which are deposits, geothermal energy is a temperature/pressure field, and as such a measure of the quantity is not based on the tangible substance in the ground (i.e. hot water and salt solutions) but on the amount of energy that can be extracted from these substances (Beardsmore, 2013).

Therefore standardization in this context comes up against these major technical challenges:

- Since the thermal energy extractible from a geothermal field is dependent on the temperature and volume of the extracted fluid, two machines on the same field with the same temperature may estimate widely different values for the energy in place, dependent on the volume of liquid they are capable of extracting at any given point. Also temperatures might be higher at greater depths within the same resource field and therefore estimates become highly subjective.
- Also in most literature, the preferred term (units) used in expressing estimates of the resource is the potential for electricity generation (MW). This neglects other possible uses for the resource. In addition, there is a further layer of complexity as the conversion factor from thermal to electrical energy depends on the efficiency of the particular machines used.
- From a geological standpoint, the conditions that delineate a geothermal field are similar to several other minerals and in some cases indicate benign deformations in the earths' subsurface. Also the resource base for geothermal energy (kinds of geothermal fields) is broad and includes some instances of unconventional resources such as hot-dry rocks where fluids are externally injected.

All of these major factors make it a daunting task to come up with any set of standard classification and terminologies for geothermal resources.Until now, a number of attempts have been made at country level to derive these standards such as the Canadian and Australian Geothermal Reporting Codes. At a global scale, the International Geothermal Association (IGA), through its Ad hoc Committee for Geothermal Resource and Reserves is leading a major initiative to harmonize terminologies and to propose a globally consistent classification scheme for geothermal energy. The Global Atlas would support this effort by gathering all existing resource maps reported in different formats to simplify the comparison of these formats and the derivation of a standard.

4.4 Creation of Services and New Datasets

The Global Atlas would provide a number datasets not specifically referencing the resource, but are very valuable and may help in mapping the resources in various locations. These includes information on regional heat-flow, temperature gradients, protected areas, thermal springs, topography, geology and fault-maps, etc.

A prominent addition currently being planned in this regard is a Global Bouguer gravity anomaly map which would help in identifying areas with gravity anomaly profiles that could indicate the right conditions for geothermal plays. It is expected that the Global Atlas would make available information that could be used by the scientific community to create new resource datasets in unexplored areas with possible opportunities for geothermal development.

5. CONCLUSION

Today, the Global Atlas for Renewable Energy (Global Atlas) is the world's largest freely accessible open source internet platform dedicated to providing spatial information on Renewable Energy. In this paper, we have provided detailed explanation on the Global Atlas; the initiative, current architecture, target audience and ambition.

The paper also provides insight on the motivation to establish a component of the Global Atlas focused on geothermal energy. It includes IRENA's technical approach to data gathering and outreach, and to the innovation of the Global Atlas internet based GIS platform to accommodate this new component.

To this end, it is worthy of note that as the world strides through the rest of the 21st Century, considering the dire needs for energy and the dynamism of the energy landscape owing to the environmental challenges we face, every single source of clean energy would be critical. From geothermal to solar, wind, hydro, and biofuels, and so it becomes imperative to ensure that geothermal is

recognized in its full rights as a potential major contributor to the global energy system wherever it is economically viable both in cases of primary (direct heat) and secondary (electricity) usage.

This can only be achieved through extensive communication, data gathering and sharing, standardization, and research and development. It is hoped that the Global Atlas would be the backbone upon which these elements are fulfilled for geothermal energy and as well for other renewable sources.

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