

**Dynamic Decision Tools Catalog and Community of Practice: Renewable Energy Installations and Environmental Impacts**

**(ESIP Energy and Climate Cluster White Paper)**

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*Disclaimer: This white paper presents individual ESIP member opinions and results of discussions held at the ESIP meetings and do not constitute direct endorsements by the government agencies and member institutions.*

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**Executive Summary**

One of the challenges Federal agencies face when reviewing renewable energy related projects (e.g. wind, solar and geothermal power site selection) is a method to assess risks associated with those projects. Project proponents and NGOs evaluating environmental impacts have similar concerns.

A number of decision support tools exist today for stakeholder use, but they lack transparency to varying degree in terms of the models used, and the data underlying the tools. Many lack clear documentation and no standardized quality control or comparison of models is currently available. Also, many software/tools developed within the government are not actually open source which could otherwise facilitate wider usage. As mobile platforms proliferate for business applications, many decision makers, both public and private, would like to have access to decision support tools via mobile devices. One of the biggest challenges is access to relevant data. And in some cases, when the tools do provide apps that offer data, they do not allow users to effectively access, download, or transform the data.

Decision-making stakeholders must be engaged throughout the “scientific knowledge lifecycle” in order to establish comprehensive and sustainable frameworks and methods for access to actionable information. Greater institutional commitment is needed from data and tool owners, and coordination as well as collaboration with developers, to keep data platforms and services as close to state of the art and open as possible.

An important step to resolving these challenges is a dynamic decision tools catalog and community of practice. The goal would be to build transparency into the decision tool architecture, data, and functionality. This would aid the decision maker in tool selection and use appropriate to their planning goals and help identify gaps and improvements needed to the kit of decision tools.

ESIP can play a coordinating role by engaging universities and industry along with the Federal agencies and NGOs in a cross-sector understanding of the needs, maintaining such a catalog of decision tools, engaging the community in a dialog and discussion, and facilitating partnerships in further tool development and application. ESIP members have completed a range of other projects dealing with semantic web, open information architecture, and Drupal based implementation, developing considerable experience and expertise that can be applied to this project.

Federal agencies that could have interest in this project and have related initiatives include the Department of Energy (DOE), U.S. Geological Survey (USGS), Fish and Wildlife Service (FWS), Environmental Protection Agency (EPA), Bureau of Land Management (BLM), USDA, Forest Service, NOAA, and Bureau of Reclamation.

**Introduction**
Renewable energy installations, e.g., wind, solar and geothermal, can impact environment and ecosystems in many different ways. Stakeholders evaluating or planning such installations need relevant information they can use to assess such impacts and associated risks through reliable decision support systems. A Task Force to Advance Risk Assessment Decision Tools was convened as an Ad Hoc Committee established by the Office of Science and Technology Policy (OSTP) in 2011[[1]](#footnote-1). This task force discussed how to coordinate renewable energy development risk assessment activities with respect to wind energy and wildlife, with the goal of making them more accessible and transparent to developers and decision makers. The committee learned that many tools are available in different sectors and realized that work is needed on quality control and transparency issues for these tools. Since many decisions cut across agency boundaries, an interagency collaboration was deemed essential.

The idea of ESIP playing a role in coordinating a decision tools catalog and community of practice to support stakeholders was initially brought up and discussed at the ESIP Summer meeting in July 2011[[2]](#footnote-2) in the context of wind power installations and impact on wildlife. Following the recommendations based on the consensus of the participants at that meeting, a workshop was held at the ESIP Winter meeting in January 2012[[3]](#footnote-3) that brought government agencies, researchers, and developers together to survey some of the available and planned tools currently being used in a broader context of renewable energy and environmental impacts, identify what stakeholder needs are being met and what remain unmet, and discuss an approach that could be taken to catalog available information, tools, and facilitate an ongoing gap analysis.

This white paper provides an assessment of needs and a potential framework for ESIP to coordinate creation of such a catalog through interagency support and help establish a community of practice.

*USGS Perspective*

The topic of decision tools for siting renewable energy projects has been discussed from local settings to the national level, from nongovernment organizations to federal and state agencies. USGS, along with many others, has been working on developing tools to assist federal agencies in making permit and other siting decisions while minimizing the impacts to wildlife and other natural resources. This research and development runs the gamut from GIS based tools, models, structured decision frameworks, wildlife and ecosystem assessment, to data management and availability. A few USGS examples include a rapid assessment methodology (RAM) and mortality estimation tools for bats and eagles, but also includes research essential to provide ecological information to support those tools like technology development (e.g. infrared video, thermal imaging, radar) for rapid eco-regional assessments, Wyoming landscape assessment, and other broad-scale population and habitat assessments. Examples of broad based tools for analyzing renewable energy and environments in use today or under development include:

* American Wind and Wildlife Institute’s (AWWI) Landscape Assessment Tool (LAT) - a tool developed from an industry-conservation organization collaboration, the publicly accessible LAT provides distribution information for more than 200 species of concern for wind energy development and other landscape-level data layers, including wind energy potential and several describing land-use and disturbance suitable for Tier 1[[4]](#footnote-4) landscape-level screening.
* USGS Rapid Assessment Methodology (RAM): method for assessing site suitability for wind energy development (Bird Conservation Region 11 pilot). The objective is to develop a quick assessment method and identify the most important natural resource considerations for decision makers.
* USGS Integrated Assessment Tool kit: Not yet released publicly. Creating an integrated ecological and resource assessment framework. This will generate an index that will help decision makers distinguish areas that are underdeveloped in terms of energy and would have very low impact on wildlife from areas that have high wildlife concentrations with low energy production potentials.
* Wyoming Landscape Conservation Initiative (WLCI): Wyoming is a large area of world class resources (natural gas, wind turbines, wildlife). Role for USGS Science is especially important to the WCLI in the creation of maps. This exercise demonstrated the importance of having people on the ground.

*Western Governors Association Perspective*

Wildlife and their habitat have always been essential to the Western way of life in many different ways. Hunters, fishermen, backpackers, birders and other enthusiasts spend their leisure time and resources viewing and engaging wildlife. Rural communities often rely on such activities to support their local economies, and they view abundant, diverse fish and wildlife as part of their Western heritage. At the same time, economic progress across the West also depends on the successful completion of energy, transportation, land use and other large-scale development projects that must incorporate potential wildlife impacts into their planning.

The Western Governors’ Wildlife Council was established in 2008 and wildlife mapping started in 2010. As a collaborative effort among 17 states, the Western Wildlife Crucial Habitat Assessment Tool (CHAT) aims to bring greater certainty and predictability to planning efforts by establishing a common starting point for discussing the intersection of development and wildlife. This entails a three step process of data development, prioritization of crucial habitats, and development of a Public Planning Tool. In its simplest form, CHAT will be an easily accessible online system of maps displaying crucial wildlife habitat and corridors across the West. While not intended for project-level approval, CHAT is designed to reduce conflicts and surprises while ensuring wildlife values are better incorporated into land use decision-making, as well as large-scale conservation projects. CHAT is under development with target completion in 2013. CHAT will have integrated and enhanced capabilities going beyond what is available today from the following multiple state systems:

* Montana’s Crucial Areas Planning System (CAPS)
* Washington’s Priority Habitat Species (PHS On Line)
* Arizona’s HabiMap
* California - Areas of Conservation Emphasis (ACE)
* 5-state Southern Great Plains CHAT

The Southern Great Plains CHAT currently provides common information about lesser prairie chicken across five states but will be expanded to include additional species. It is currently used by utility companies and wind developers in Kansas and Oklahoma; it is also used by the Natural Resource Conservation Service to give compensation to areas to deter development that would have a profound impact on wildlife. Wyoming will release their state-CHAT in 2012, the Wyoming Interagency Spatial Database and Online Management System (WISDOM). Technical work to complete the West-wide CHAT in 2013 includes collecting and compiling west-wide data, accommodating state specific needs, and putting together different options for developing a west-wide GIS viewer application.

Since a lot of effort and resources go into building the geospatial tools, the biggest challenge in this initiative has been to make the western states build something that’s a benefit in the long term and will be frequently used. States need to understand the needs of the renewables industry as well as those of the conservation planners so it will better equip them to review energy projects they are considering themselves. Support from industry GIS experts would be helpful in developing all the key data layers for each state. Outreach to learn how the public might use this tool is critical and is a current challenge.

*DOE Perspective*

A panoply of data, models, visualizations, analyses, software and decision tools exist today. The problem is that many of these are not accessible, transparent, “open”, distributable, mobile, location aware, up-to-date, or even licensed for use outside of their single use development environment. Developers of these solutions, whether they are a Government Agency, NGO, or other interested group build their solution within their zone of control with visibility and access available only through their single destination site.

Content aggregators and redistribution assets such as OpenEI.org and Energy.data.gov are platforms that leverage crowd sourcing and linked open data solutions to build ecosystems for the transmission, storage, analysis and distribution of energy data and information. These systems provide mapping and other visualization tools to transform that raw data into understanding. By building open crowd sourced catalogs of highly interactive resources and an engaged community of solution providers, OpenEI and Data.gov bring powerful distribution engines for use by anyone. Capable of connecting to virtually any data or content source and conveying that access to other destinations, they transform understanding and access to knowledge and resources which otherwise would be inaccessible or at best diffused across the community in such a way as to be nearly impossible to find.

The development of a decision support application including an online asset catalog and deploying open development platforms intended for use by energy policy-makers is a substantive step forward to reducing the up-front soft costs associated with renewable energy installation. Easy and open access to innovative tools and online resources accessible across many destinations by audiences of all types would support the needs of the renewable energy analysts and installers prior to investment.

**Key Stakeholder Needs**
Through discussion of current and planned tools at the ESIP workshop, some common themes emerged that could make not only the existing tools more powerful but also facilitate development of new tools that could enhance access to information, and enable decision making.

*Interoperability*

Each of the currently available tools serves a purpose and a catalog of such tools would be beneficial. The approach thus far is not coordinated among agencies and organizations who are managing these tools from their own individual perspective. Cross-referencing and interoperability are major issues.

*Open Source*

Many software/tools developed within the government are not actually open source as defined by the Open Source community. A true Open Source solution must include free redistribution, distribution in source code and compiled format, must allow source code modification and derived works, should support the integrity of the author’s source code, cannot discriminate against persons, groups or fields of endeavor, must allow for the distribution of license and said license cannot be specific to a product. Finally must not restrict other software and must be technology neutral.

It may be worth taking a look at moving some of the software engineering development out of government and into the global open source software marketplace. It may be beneficial to publish the application development work so that it can be carried forward by the community at large and is not lost when one group loses interest or drops out.

*Mobile and Social Networking Platforms*

With more than 5.9 billion mobile subscribers worldwide, nearly 11 billion downloaded mobile applications and one in three persons in the USA using smart phones, it is clear that any solution must be developed in such a manner as to be used where, and when the user needs it. Decision makers will need access to decision support tools via mobile devices with the ability to leverage location awareness features available in most mobile devices; this is surfacing a need to develop new vehicles for communications like applications on smart phones, Facebook, or others that could be beneficial when community involvement is at stake.

Social media sites such as Facebook provide further evidence in support of building this solution in a highly distributable format. With more than 900 million users, Facebook is now used by 1 in every 10 people on earth. Over 200 million people access Facebook via their mobile phone and more than 250 million people interact with Facebook from outside the official website on a monthly basis across 2 million websites.

*Data Access and Exploitation*

One of the biggest challenges is access to relevant data from disparate data sources. Some tools such as OpenEI provide applications that offer data, but they don’t allow users to play with the data. DOE is sponsoring development of apps for solar siting, geothermal, and considering an app for wind power siting. The app for solar, for example, will give information on how much energy solar panels would generate and what sort of federal/state rebates and incentives are available for installing panels (a beta solar app is expected by March 2012). What is needed is a consistent framework for data access and use. Greater institutional commitment is needed from data owners to keep data platforms and services as close to state of the art and open as possible. *Scientist and Stakeholder Engagement*

A rigorous user centered design process properly engaging stakeholders should be the first step of any development process in support of this initiative. Decision-making stakeholders must be engaged throughout the “scientific knowledge lifecycle” in order to establish comprehensive and sustainable frameworks and methods for access to actionable information. End users include scientists engaged in research as well as stakeholders planning and deploying renewable energy infrastructure, and authorities concerned with the environmental and ecological impacts. Working with management agencies early on in the collaboration would be beneficial in developing long-term strategies that include an adaptive management process. Stakeholder’s workshops with decision makers (e.g., Western Governors Association, other groups) and funding agencies could provide appropriate forums.

**Enabling Technologies**

In this section we take a look at some of the technologies that can help in addressing the stakeholder needs identified above.

*Semantic Web*

One of the continuing challenges in any research investigation is the discovery of and access to useful science content from the increasingly large and scattered volumes of science data and related information available. Similar obstacles are faced in the renewable energy arena, specifically in relation to siting new facilities, because of potential environmental and human impacts. For example, solar energy installations can threaten wildlife and detract from nearby historic buildings. Similarly, wind turbines can pose threats to wildlife and air traffic. To solve such problems requires discovery and effective use of interdisciplinary data, information and tools. One technical approach to this problem is the use of “semantic aggregators” for gathering information from several different sources. Advances in aggregator technology and semantics now provide for content “curation”, where in addition to gathering information, the aggregator tool organizes, categorizes and ranks content by relevance.

The "Semantic Web" refers to a set of technologies blessed by the World Wide Web Consortium (W3C) for representing the meaning of information in a standardized way so that others (human and computer) can understand the specific concepts we wish to convey without the inherent ambiguities and confusion of ordinary natural language[[5]](#footnote-5).

Much of the existing web is based on XML infrastructure. Semantic web provides layering capabilities on the XML infrastructure[[6]](#footnote-6). There is no single set of standards for semantic web. OWL (ontology web language) can capture classes, properties, data types, various associative properties, etc. The query language SPARQL is much like SQL. Rule Interchange Format (RIF) has been standardized, tools are just now starting to emerge but there are a large number of ways to encode tools. Semantics web development requires domain expertise, use cases, and a methodology to proceed with knowledge extraction.

*OGC and Open Information Architecture*

The challenge of providing access to diverse models, analytic tools, source data and products to a wide variety of end-users necessitates a flexible information architecture that can accommodate multiple access and delivery methods. Key standards from the Open Geospatial Consortium (OGC) include map visualization (WMS), representation (KML), data access (WFS & WCS), and processing services (WPS) can play an important role in such architecture. Other OGC Services of potential applicability are Sensor Web Enablement, Catalog Service, Geography Markup Language (GML) and Network Common Data Form (NetCDF). In particular, what is needed is an architecture that can integrate OGC services into a broader system for discovery, access, and curation by users that range from the general public to users with specialized analytic skills and tools, geospatial and otherwise. ESIP members have substantial experience in designing architectural frameworks implementing OGC services. An open information architecture model (which includes OGC services) exists that can be leveraged and tailored within which a growing renewable energy and environmental evaluation community of practice can participate. If we can, as a community, move towards interoperability standards, we will be in a better position in leveraging the investments by other communities. We will need to think about what specific capabilities we need to develop to make use of community developed resources to produce end-user applications.

*Drupal*

Drupal is a popular open source Web Content Management Framework used to create a wide range of websites. It’s creative capacities range from basic websites to a full feature portal to support an online community. Drupal is widely utilized to create portals within the scientific community to catalog and share science artifacts. Key features and functionality include an extensive administration and user interface, custom content types, versioning, taxonomy support, search support, a template and theme system which allows one to change the look/feel without having to change the html, and a very nice user management system that allows one to make very fine grain changes. Drupal has a very minimal software stack, yet provides capabilities of PHP, MySQL and Apache. Drupal has been used for document/data/metadata management, and is well suited for community based frameworks. Examples of Drupal implementation are NASA JPL DAAC, and DOE Bioenergy KDF (has a tools & apps catalog).

**ESIP’s Role**

ESIP can play a significant role in multiple ways. First of all, ESIP can help by providing channels to data and analysis tools that can then be used to make apps tailored to energy stakeholders needs. This will require leadership and direction from ESIP members and data owners in pointing to where the data are and how to get it flowing. Evidently, the stakeholders, critical to renewable energy development, hold a variety of perspectives and viewpoints on the issue. ESIP, through its decades of engagement with these stakeholder communities as well as through its multiagency sponsorships, occupies a unique role in its ability to bring together and address their diverse needs and goals.

For example, CHAT, currently being developed by Western Governors Association, can benefit from support in developing the key data layers for each state, and in developing a geospatial tool that will do everything desired by the stakeholders – that will involve a lot of learning about the technology and its applications for public usage. WGA is also struggling to develop proper outreach strategy to the public (i.e., when/how to do the outreach to design the GIS systems to be used the right way). Support from GIS experts and insights from the ESIP community on how the public might use this tool could help significantly in this process.

It may be appropriate for ESIP members to prototype a tool that will use a semantics-based content aggregation approach to improve discovery and use of disparate data, tools and related information for a specific renewable energy-siting problem. ESIP has considerable experience in implementing semantic web based solutions[[7]](#footnote-7). The Semantics Cluster within ESIP has produced tutorials, ontologies, technical infrastructure, applications and demonstrations. Examples include Semantic Web for Earth and Environment Technology suite[[8]](#footnote-8), and Drivers Pressure State Impact Response (DPSIR) decisions making framework which has semantics coding for energy management in Europe. ESIP also has experience in implementing Drupal; an ESIP product and services testbed can be leveraged to host a Drupal based catalog.

The design and development of an architecture and community of practice infrastructure to support the exchange of energy related information and analysis tools can benefit from examples and lessons learned in adjacent disciplines. Experiences from ESIP members in information system interoperability activities, such as the Air Quality Workgroup and Global Earth Observation System of Systems Architecture Implementation Pilot, provide reusable elements and lessons learned for the energy community. This includes a foundational architectural perspective based on general information flow principles. For example, observations and models generate the data, which are analyzed and fed through the GEO information systems, and then disseminated to inform decision making. ESIP can identify and work with different groups involved (e.g., one that has data and another that has a use application) and figure out what is needed to attain interoperability between them. Another value ESIP brings is providing expertise on how to implement the standards using particular implementation conventions as interoperability cannot be achieved otherwise (e.g., netCDF has many implementations). Furthermore, Community Collaboration Portals (i.e., wikis) that ESIP has substantial experience with can help with that coordination. ESIP membership includes many end users and stakeholders; hence ESIP can play a significant role in collecting and organizing public feedback on the viability of tools and learn about changing requirements on an ongoing basis.

**Conclusion**

A number of decision support tools exist and are in use today, but differ greatly in capabilities and scope, with some offering quite powerful capabilities for renewable energy development decision problems. Government agencies and institutions in private sector are upgrading them incrementally and on as needed basis. Much of the work is happening independently, however, and is driven by each agency/organization’s key requirements. A multitude of data sources, access to that data, and lack of interoperability among tools are some of the major issues in making the tools accessible and operable.

ESIP, with its active membership from government, academia and the private sector, and neutral forum for collaboration, is well positioned to support cross-agency cross-sector efforts for coordinating a decision support tools catalog and community of practice to facilitate data access and dissemination for renewable energy installation and environmental impacts. With a successful record of completing other projects dealing with the semantic web, open information architecture, and Drupal based implementation, ESIP members will provide considerable experience and expertise that can be applied to this project. By implementing such a crosswalk for renewable assessment, ESIP can create a standard or a ‘Rosetta stone’ for similar assessment activities that can be applied in other Earth Science disciplines.

1. Need Reference [↑](#footnote-ref-1)
2. ESIP Energy and Climate Cluster Meeting July 13-15, 2011, <http://wiki.esipfed.org/index.php/Energy_and_Climate_Cluster_Summer_Meeting_Agenda> [↑](#footnote-ref-2)
3. ESIP Energy and Climate Cluster Workshop Jan 4-5, 2012, <http://wiki.esipfed.org/index.php/Energy_and_Climate_Cluster_Session_Abstract> [↑](#footnote-ref-3)
4. As defined in the USFWS “Land-Based Wind Energy Guidelines”, March 2012, 82 pages [↑](#footnote-ref-4)
5. http://earthdata.nasa.gov/our-community/esdswg/technology-infusion-tiwg/semantic-web [↑](#footnote-ref-5)
6. http://wiki.esipfed.org/index.php/Semantic\_Web\_Tutorials [↑](#footnote-ref-6)
7. http://wiki.esipfed.org/index.php/Semantic\_Web [↑](#footnote-ref-7)
8. http://sweet.jpl.nasa.gov/ [↑](#footnote-ref-8)