A Survey on the Use of Web Technologies in the Promotion of Sustainable Energy

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Abstract—**Energy crisis and climate changes are now recognised as the key challenges faced by the human race. Many researchers are working towards solutions for the problems. One of the solutions is a wider use of sustainable energy to replace the traditional carbon-based resources. In order to support the researchers to develop this solution, current and up-to-date information and knowledge should be provided and made accessible automatically. One such channel is the World-Wide-Web. This paper surveys web technologies that are currently used to promote sustainable energy on the Web. This information will be used to support the next phase of a research aimed at extracting relevant information from the World-Wide-Web on sustainable energy automatically.**

I. INTRODUCTION

Energy is essential for the human society. Since the discovery of fire, human race has utilized energy for survival and comfort. Energy is now indispensible for daily personal living, dwelling and shelter for the family, social functions and gathering, communal interactions and transactions of all forms, and, the building and defense of every nation. Most of resources that are used to produce energy are fossil or carbon based in the forms of crude oil, coal and natural gas [1]. Despite the debates on the exact amount of such resources available in the world, it is undeniable that such forms of energy resources are finite. In addition, excessive use of such resources has been alleged that it has led to climate change and global warming. The potential crisis of the eventual depletion of the traditional energy sources and climate change will have huge and dire impacts on the environment [2] and the subsequent human generations[3].

The awareness of these environmental problems has been increasing due to the escalation of energy cost and changes in the weather patterns. There are many researchers who have been working on solutions for these problems. One of the solutions is increase the use of Sustainable Energy (SE). Sustainable energy in the forms of solar, wind, tides, hydropower and geothermal energy are available infinitely and have minimum impacts on the environment[4]. Therefore, SE is essential as a substitute to the non-renewable energy so as to preserve the limited traditional energy resources and the environment for the subsequent generations.

One way to accelerate sustainable energy development is the dissemination of information and knowledge to the community. This will assist researchers and related stakeholders who are working on sustainable energy system or involved with the associated services. As far as the general public is concerned, they should be made aware of the need and how to use sustainable energy efficiently.

One of the most effective ways in distribution information and knowledge is the Internet and the World-Wide-Web. At present, there are many websites providing sustainable energy information and knowledge for themselves and/or the public. These sources may contain current or up-to-date information on the subject of SE. Hence, it will be useful if an automated process could be implemented to gather and extract the relevant information from these sources. The first phase of such research and development is a survey and study of these sites.

In this work, over one hundred websites have been investigated. They have been categorised according to the nature of the organisation, target user of the site and the web technologies employed. It is noted that a range of web technologies have been used to provide the relevant SE information. In this paper, the finding from this aspect of the study is reported.

The structure of this paper is organised as follows. Section II provides the descriptions of the various forms of web technologies used. Section III describes the methodology in selecting the list of websites and the categorization of the information. Section IV is the results and Section V is the conclusion and discussion. This is followed by a selected list of websites in the Appendix and the list of references.

II. WEB TECHNOLOGIES

World Wide Web is a service on the Internet conveying electronic documents, which are called web pages, through Hypertext Transfer Protocol (HTTP) between web servers and web browsers. Web pages are generally categorised into two types: Static web pages and Dynamic web pages. The former is a form of one way communication. For example, a provider provides information or knowledge on sustainable energy, and the users can only read the information on the web page. The users are not able to filter the information according to their needs. The information on static web pages is formatted by using Hypertext Markup Language (HTML), and they have *.html* or *.htm* as file name extension. On the other hand, dynamic web pages are created by using a combination of

HTML and web programming languages or scripting languages. Such files can be identified by the various types of file name extension. From a user's perspectives, the user can interact with dynamic web pages in different ways, such as searching for particular information on any web page, or performing calculation such as the amount of carbon dioxide that is released to the environment based on a variety of parameters. In addition, information on the web pages can be changed or updated by providers easily.

Web programming languages have many forms, and some of them are described as follows:

- *PHP (Hypertext Preprocessor)* is an open source scripting language by embedding the codes into HTML pages[5]. It is processed at server side, and the results are then sent to web browser. It uses .php as a file name extension. In addition, most of the web server can work with PHP[6].

- *ASP (Active Server Pages)* is developed by Microsoft and it works on only Microsoft web server, which is also known as Internet Information Services. Also, it is a server side processing with an .asp extension. Microsoft has introduced another format for web page development, which is ASP.NET. This works on .NET platform and it uses .aspx as the file name extension.

- *ColdFusion Markup Language (CFML)* is also a server side processing like PHP and ASP. However, the developer can integrate database technologies by combining HTML and CFML. The extension is .cfm; however, it works better in a ColdFusion-based environment[7].

- *Java* technologies are introduced by Sun Microsystems. One of the technologies is JSP (Java Server Pages). Like ASP, JSP is a server side processing, but it is an open source scripting and platform independent[7]. There are various java technologies for web development such as Servlet or applet, and they are used for different purposes.

Web technologies have been developed and are advancing continually. Information providers can choose one of the technologies as a basis for providing their information on the Web. In this research, sustainable energy is the target information to be acquired from the Web the associated developing technologies are therefore the focus of interest in this study.

III. METHODOLOGY

A. Collection of websites

The websites that provide Sustainable Energy information are collected through the process as shown in Figure 1. This process is similar to that as proposed in Croft [8]. The initial sources are found by using the most popular search engines. There are Google (www.google.com), Yahoo (www.yahoo.com), Cuil (www.cuil.com) and Kartoo (www.kartoo.com). Then, the key words, "sustainable energy" are used as seeds in the searching process. After a result is displayed, the first website was fetched for

evaluation. Subsequently, this process chooses the links that are provided by each website and this leads to the evaluation next website. Next, after the loop of the first website is finished; the second website on searched result is evaluated in the similar manner. This process stops after the first ten in each search, and total number of sites collected in the initial phase is 100.
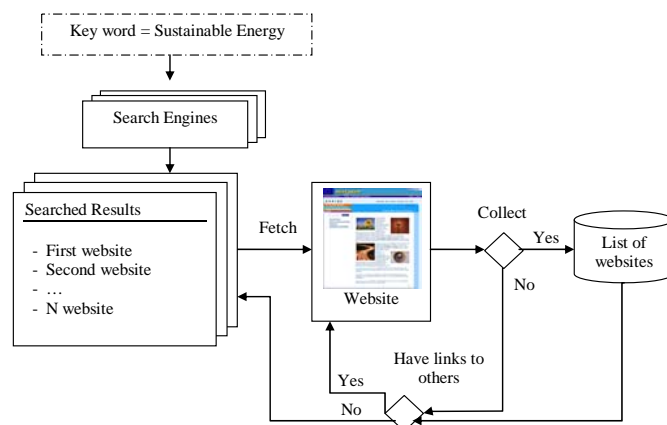

Fig. 1. Process for websites collection

B. Criteria for websites selection

This study evaluated the websites using Barker's process of web pages evaluation[9] . The target information is sustainable energy with an objective to encourage awareness and enhancement of knowledge about the sustainable energy. At the present phase, only information based on English are collected. This study first of all looks at the structure of URL, type and name of the domain in URL. Moreover, this study has set the priorities or order of importance of the websites as follows:

1. Governmental websites are considered with the highest priority. It is understood that many governments are providing sustainable energy information for their citizens and other governmental departments. As these sites are normally well funded and supported, it can be expected that the information will be current and updated.

2. Non-profit organisation websites are considered having the second priority. This type of websites has strong and focused objective in sustainable energy. Furthermore, these organisations may be established by many organisations from multiple countries. Their nature may be non-commercial or commercial with many groups of people, or a few participants cooperating on the common interest of sustainable energy. Most of the information are about ongoing or completed projects. As a result, user can gain knowledge from these projects on these websites.

3. Educational websites are considered having the next priority as mostly are teaching or research information provided by groups of people within the academic or research sectors. Most have the objectives of assisting users to apply relevant information in order to develop sustainable energy technologies, systems or related services.

4. Business websites are the ones with the next priority because most information are related to commercial products or services. They provide information on goods and services based on sustainable energy and the users can also learn about applications in the commercial sectors.

Next, the authors and objectives of the websites are determined by investigating the "About us" links. Relevant information can also be used to evaluate the contents on the websites including the time of the last update. After this, the various forms of information in sustainable energy information are considered, and references of the information are looked up.

This study has excluded personal pages, unclear and ambitious objectives or information. For example, the websites excluded a tile symbol (~) following general person name, or there was no mention about objectives of information in website are ignored from the list. In addition, any temporary web pages such as an advertisement on sustainable energy conferences are not included. On the other hand, if the website is using two web technologies such as ASP and ASP.NET, it is categorised in the group of the latest technology.

C. Categories of the websites

This study categorises the websites based on the following categories: Country, Continent, Provider and Technology as shown in Table I.

Country, Continent and Provider category are considered because they help the next phase process of this research which will focus within a boundary that where sustainable energy information will be extracted.

The Technology category has three sub categories: Web Technology, Web feed formats, and Web server. This criterion has implication on the ease of publication or modification of the web contents. For example, if any static web page is developed with HTML, any information following a layout in its website will require more time to develop than the dynamic web page developed with other technologies such as ColdFusion, PHP or ASP.NET. Therefore, the sustainable energy information on website developed in different web technology may take longer lead

TABLE I
CATEGORIES OF THE WEBSITES

Category	Sub Category	Description
Provider	- Government	This category means a type of organization, which provides sustainable energy information
	- Nonprofit-Organization	
	- Education	
	- Business	
Countries and Continent		This category means country where an organization or a head office which organise the website has located in.
Technology	- Web Technology	This category means web technologies that support to provide sustainable energy on World Wide Web.
	- Web Syndication Technology	
	- Web Server	

time to be published or modified. Furthermore, different techniques on automatic extraction of the sustainable energy information should also take into account of the variety of the web technologies used.

IV. RESEARCH RESULTS

This study so far has collected 113 websites in the past month. There are 42 non-profit organisation websites (37.17%), 32 business websites (28.32%), 31 government websites (27.43%) and 8 educational websites (7.08%). 59 of these websites are hosted at Europe (52.21%). North America and Oceania websites are numbered at 38 and 14 websites (33.63% and 12.39%) respectively. The rest of the websites are located at Africa and Asia.

TABLE II
THE RESULT OF THE WEBSITES GROUPED BY TYPE OF ORGANIZATION

Type of organization	Number and Percentage of the websites	
Non-profit Website	42	37.17%
Business Website	32	28.32%
Government Website	31	27.43%
Educational Website	8	7.08%
Total	113	100.00%

TABLE III
THE RESULT OF THE WEBSITES GROUPED BY CONTINENT

Continent	Number and Percentage of the websites	
Europe	59	52.21%
North America	38	33.63%
Oceania	14	12.39%
Africa	1	0.88%
Asia	1	0.88%
Total	113	100.00%

The survey has found that most of the websites are developed with web technology that can organise data on their website easily, and the most popular web technology used is PHP on 32 websites (28.32%). The other popular technologies used are ASP, HTML, ColdFusion, ASP.NET and Java technology with 24 websites (21.24%), 15 websites (13.27%), 10 websites (8.85%), 9 websites (7.96%) and 7 websites (6.19%), respectively. The rest of the websites are developed with special technology such as Perl, SHTML, CGI, Python and TML.

There are still some websites based on HTML for providing sustainable energy information. In other words, this could be an obstacle on providing updated information on the websites since it is likely that extra time is required to reorganise the data.

In the case of web server platforms, Apache server is the most popular web server that is used. There are 58 websites (51.33%) using Apache and the second most popular web server is IIS from Microsoft with a number of 42 websites or 37.17%. There are 3 websites with unknown server technology used and the rest use other web server brands. This includes AkamaiGHost, AOLserver, Netscape-Enterprise, nginX, Oracle-Application server, Roxen, Sun Java System web server, Sun ONE web server and Zope.

TABLE IV
THE RESULT OF THE WEBSITES GROUPED BY WEB TECHNOLOGIES

Web technologies	Number and Percentage of the websites	
PHP	32	28.32%
ASP	24	21.24%
HTML	15	13.27%
Cold Fusion	10	8.85%
ASP.NET	9	7.96%
Java Technology	7	6.19%
Undefined	7	6.19%
Perl	4	3.54%
SHTML	2	1.77%
CGI	1	0.88%
Python	1	0.88%
TML	1	0.88%
Total	**113**	**100.00%**

There are only 22 websites (19.47%) providing sustainable energy information through web syndication technology, while the rest of the websites do not provide such service. Moreover, only 2 websites provide service in both RSS and atom format, and 20 websites provide service in RSS format only. All the above information are summarized in Table II to V.

TABLE V
THE RESULT OF THE WEBSITES GROUPED BY WEB SERVER

Web server	Number and Percentage of the websites	
Apache	58	51.33%
Microsoft-IIS	42	37.17%
Undefined	3	2.65%
AkamaiGHost	1	0.88%
AOLserver	1	0.88%
Netscape-Enterprise	1	0.88%
Nginx	1	0.88%
Oracle-Application-Server-10g	1	0.88%
Roxen	1	0.88%
Sun-Java-System-Web-Server	1	0.88%
Sun-ONE-Web-Server	1	0.88%
World Bank Web Service	1	0.88%
Zope	1	0.88%
Total	**113**	**100.00%**

V. CONCLUSION AND DISCUSSION

The use of sustainable energy is one of the possible solutions to reduce the environmental impacts and to address the problem of energy crisis. Sustainable energy development can be sped up through dissemination of information and knowledge to researchers and related stakeholders through the World-Wide-Web. It will therefore be useful and valuable to extract the related information on the World-Wide-Web automatically.

This paper presents the first phase of a research project by surveying the web technologies being used to provide sustainable energy information and knowledge on the World-Wide-Web. A methodology for extracting the information is described with the intention that it will be implemented for automatic operations in the future.

Information from over one hundred websites which are providing sustainable energy information and knowledge have been collected. The result shows that most of the websites are managed by non-profit organisations (37.17%) and most of the information come from Europe (52.21%). Also, it is observed that PHP (28.32%) is the most popular web technology used. Moreover, the most popular web server that is used to provide sustainable energy information is Apache (51.33%).

The next phase of the research will take this result into account while the trend of web technology will be noted. The focus of the subsequent research will concentrate on the most appropriate way to extract sustainable energy information and knowledge automatically from the Web.

APPENDIX : A SAMPLE LIST OF 20 WEBSITES ON SE

1. http://www.sustainableenergycoalition.org
2. http://www.ncsustainableenergy.org
3. http://www.gosustainableenergy.com
4. http://sustainable-energy.us
5. http://www.nesea.org
6. http://www.undp.org/energy
7. http://www.unep.org/themes/energy
8. http://www.easternct.edu/depts/sustainenergy
9. http://www.sustainableenergy.com
10. http://www.sustenergy.org
11. http://www.cse.org.uk
12. http://www.sedo.energy.wa.gov.au
13. http://www.sei.ie
14. http://www.sustainability.gov.au
15. http://www.world-nuclear.org
16. http://www.ashdenawards.org
17. http://www.energia.org
18. http://www.energie-cites.eu
19. http://www.ntr.ie
20. http://www.nwseed.org

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