Web based system for Renewable Energy Sources assessment

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Abstract: *The **RES_Assess** software is developing to assist in the preliminary assessment of potential renewable energy projects. First released include water pumping solar systems, passive solar systems, wind, and geothermal energy and biomass. The program guides the users in the design of their systems, by providing initial estimates. By changing the system's parameters, users are able to quickly screen an effective technology and system size depending on load, climatic conditions, and season of use. This paper describes scope of models (radiation, wind, geothermal, heat transfer) used to predict energy production from energy resource systems, climatic variables and system parameters and software technology for realising the project.*

Keywords: *Energy projects, Renewable energy, Web system*

1. INTRODUCTION

Many software tools have been developed for energy assessment of Renewable Energy Sources. The first group of these products is so called '*easy to use calculators'* [1] for different renewable technologies. These are simple software applications, which use suitable mathematical models for specified energy resource. These software tools are not suitable to make detailed energy and economical assessment for a project performance.

RETScreen Clean Energy Project Analysis Software [1,2] is the design tool, which is the world's leading clean energy decision-making software. It is provided completely free-of-charge by the Government of Canada as part of Canada's recognition of the need to take an integrated approach in addressing climate change and reducing pollution. The core of the tool consists of standardized and integrated renewable energy project analysis software that can be used worldwide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of renewable energy technologies (RETs). RETScreen is collection of static analytical models for different Renewable technologies. The software consists of easy-to-use Microsoft Excel spreadsheets.

The *Maui Solar Design Studio* is an advanced solar system design tool, suite of somewhat "Easy to use" tools, modules for both PV and solar thermal technologies [6,7]. It includes tutorials, hourly simulation results, system performance analysis, 30 year datasets for 237 US locations, financial analysis tools, load analysis optimization, hourly analysis e.t.c.

The *F-Chart* is the authoritative solar thermal system analysis & design tool [6,8]. Software includes modules for solar thermal and PV technologies, monthly performance results, system performance analysis, weather data for 300 locations, economic Analysis.

The *TOPFARM* project addresses optimization of wind farm topology and control strategy as based on detailed aero elastic modelling of loads and power production in a coherent manner [6]. The outcome of the TOPFARM project is a toolbox, consisting of advanced dynamic wake load models, power production models, cost models and control strategy models, and the synthesis of these models into an optimization tool.

Presented literature review shows, that available software tools are both static (excel spreadsheets) or dynamic models for specified renewable technologies only. There is not complete design tool for different renewable energy resources and dynamic (simulation) models.

A new project for software product for Renewable energy assessment – **RES_Assess** is presented in this paper. It could be an innovative and useful renewable energy awareness, decision-support and capacity-building tool. The core of the tool consists of standardised and integrated renewable energy project analysis software to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of renewable energy technologies (RETs). The software consists of easy-to-use Web forms for collecting an initial project data. In addition to the software, the tool includes: product, weather and cost databases; an online manual; a website; project case studies. In complete design RES_Assess will provides a common platform for evaluating project proposals while significantly reducing the costs, associated with preparing preliminary feasibility studies. In addition, the tool will be suitable for educational and industry/market development purposes.

The Software is based on various models used to calculate, on a month-by-month simulation basis, the energy production of Renewable Energy Sources systems. They include models to compute solar, wind geothermal or other energy using daily distribution of climatic parameters and consumer demands. The models use the concept of utilizability to evaluate the interaction of the various components of the system and predict how much energy (or water, in the case of a pumping system) can be expected from the system on an annual basis.

RES_Assess allows decision-makers and professionals to determine whether or not a proposed renewable energy, energy efficiency, or

cogeneration project makes financial sense. If a project is viable — or if it is not — RES_Assess will help the decision-maker understand this: quickly, unequivocally, in a user-friendly format, and at relatively minimal cost.

2. WEB SITE OF RES_ASSESS SOFTWARE

The main Web page of *RES_Assess* Web site is presented in fig. 1. The initial version of this Web site is available on the address: http://www.renenergy2011/Ret_Assess/index.htm.

The technologies included in final release of RES_Assess’s project models will include renewable energy sources of clean energy as well as conventional energy sources and technologies. Project models ensure facilities for the next assessments: energy efficiency, heating and cooling (e.g., biomass, heat pumps, solar air/water heating, geothermal systems), power (including renewables like solar, wind, hydro, geothermal, etc.), and combined heat and power (or cogeneration).

Each model also will includes equipment characteristics, cost and weather databases and a detailed online user manual, all of which help to reduce the time and costs associated with preparing pre-feasibility studies. The RES_Assess Software can be used to evaluate industrial, commercial, institutional, community, residential and utility applications for the following technologies:

Wind Energy Project Model for central-grid and isolated-grid connected projects, ranging in size from large-scale multi-turbine wind farms to small-scale single-turbine wind-diesel hybrid systems, water pumping system etc. The mathematical model renders an account to the available meteorological data (monthly mean wind speed, wind speed distribution etc.) and turbine power curves.

Photovoltaic Project Model for on-grid (central-grid and isolated-grid PV systems), off-grid (stand-alone (PV-battery), hybrid and water pumping applications (PV-pump systems).

Solar Heating Project Model for ventilation air heating and process air heating applications of transpired-plate solar collectors, as well in the air-drying processes.

Solar Water Heating Project Model for domestic hot water; industrial process heat and swimming pools, heating in buildings with heat pumps ranging in size from small residential systems to large scale commercial, institutional and industrial systems.

Passive Solar Heating Project Model for passive solar designs, energy efficient windows use in residential and commercial building applications, massive walls, greenhouses, heating roofs etc.

Biomass Heating Project Model for biomass and waste heat recovery (WHR) heating projects. The model would be used to evaluate waste heat recovery, biomass, and biomass and waste heat recovery combined.

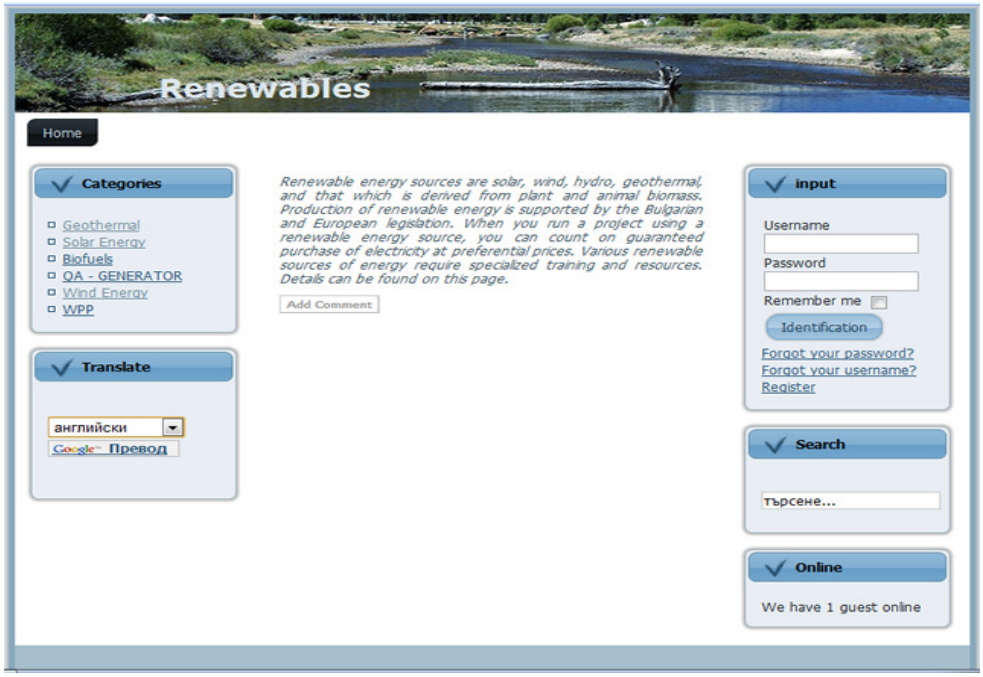

Fig. 1. Main Web Page of RES_Assess Web site

Geothermal and Ground-Source Heat Pump Project Model for heating and cooling of residential, commercial, institutional and industrial buildings using direct thermal systems, ground-coupled (horizontal and vertical closed loop) or groundwater heat pumps. Models use temperature distribution in earth layers and season accumulation effects.

Web site comprises client Web applications for communications with the users and server applications for solving the mathematical models and assessing procedures for renewable energy projects. Software is developing by well-known software developer tool Delphi (Embarcadero RAD Studio).

3. RES_ASSESS TECHNOLOGY

Software is developing by ***Embarcadero RAD Studio*** and ***Delphi for PHP*** software. These is an object-oriented, visual programming environment for rapid application development (RAD). Embarcadero RAD

Studio provides all the tools, needed to model applications, design user interfaces, automatically generate and edit code.

The Web part of Embarcadero RAD Studio is developed as a conceptual background for building ***WebSnap*** applications. WebSnap makes it easier to build Web server applications that deliver complex, data-driven Web pages. The base of WebSnap facilities in RAD Studio is ***IntraWeb*** technology.

IntraWeb is a new way to create web-based applications. Built upon *Web Solution Builder*, it extends the technology by providing an excellent tool for creating internet, intranet and extranet applications in a quick and easy to maintain manner.

IntraWeb works much like a normal executable application, with the exception that the user interface is a web browser instead of a window. After placing the application on a web server, a user can run an instance of the application by using a URL to start a session. The user's information will be tracked by the instance of the application in use, thus preventing data loss or accidental intermingling with another user's data. For each user, new session information is created and tracked automatically and is transparent to the developer. The overhead is low and the capacity of an IntraWeb application is similar to that of other web solutions such as ISAPI, CGI, or ASP.

IntraWeb allows developers to create applications in a true RAD manner by dragging and dropping components on an IW form, defining events and setting properties in a way that is similar to popular RAD environments like Delphi or Microsoft Visual Studio.

No HTML, CGI or JavaScript skills are required, all coding can be done with making use of Delphi or any other language you use on the .Net platform. Additionally, JavaScript may be used to implement custom client-side features (see Overview, Areas of Implementation).

The main technology scheme of IntraWeb is described in fig.2. When the Web application receives an HTTP request message, it creates a HTTPApp.TWebRequest object to represent the HTTP request message, and a HTTPApp.TWebResponse object to represent the response that should be returned. The application then passes these objects to the Web dispatcher (either the Web module or a *TWebDispatcher* component).

The Web Dispatcher controls the flow of the Web server application. The dispatcher maintains a collection of action items (*TWebActionItem*) that know how to handle certain types of HTTP request messages. The dispatcher identifies the appropriate action items or auto-dispatching components to handle the HTTP request message and passes the request and response objects to the identified handler so that it can perform any requested actions or formulate a response message.

The action items are responsible for reading the request and assembling a response message. The content producers can make use of other content producers or descendants of *THTMLTagAttributes*, to help them create the content of the response message.

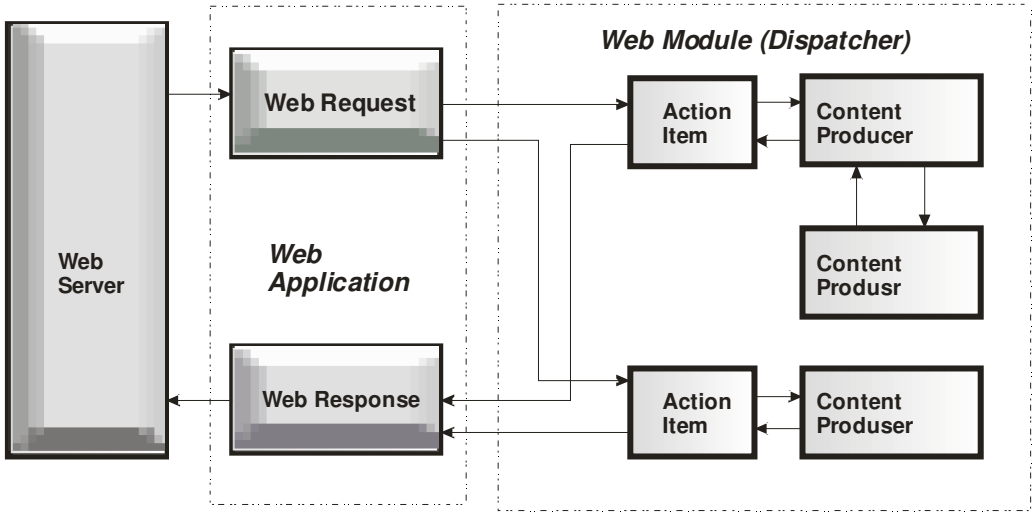

Fig.2 Schematic diagram of IntraWeb technology

If there is needed creating the Web Client in a multi-tiered database application, the Web server application may include additional, autodispatching components that represent database information encoded in XML and database manipulation classes encoded in javascript.

When all action items (or auto-dispatching components) have finished creating the response by filling out the *TWebResponse* object, the dispatcher passes the result back to the Web application. The application sends the response on to the client via the Web server.

4. CONCLUSION

Web based system RES_Assess would expand the public knowledge for renewable energy technologies, encouraging the implementation of energy efficiency measures, and contributing to a sustainable energy future. As the world moves towards addressing climate change and further protecting the environment, this project intends to encourage initiatives for RES energy developments and projects. The models included in this software project provide a set of equations that lend themselves well to an efficient simulation procedures and implementations. The incorporation of

these models into RES_Assess makes it possible to compare quickly the benefits of renewable energy systems to those of conventional energy sources. The models go into enough detail that meaningful physical phenomena are taken into account, while at the same time retaining enough simplicity to minimize data input requirements for users. The improvements in accuracy due to the use of hourly data, rather than monthly data used in most other renewable energy design models, are important.

5. REFERENCES

[1] Leng G et al., RETScreen, Renewable Energy Project Analysis Software. Available free-of-charge from NRCan/CEDRL at http://retscreen.gc.ca

[2] WATSUN-PV 6.1, Department of Systems Design Engineering, University of Waterloo, Waterloo, ON, Canada N2L 3G1.

[3] CANMET (1991). Photovoltaic systems design manual. Natural Resources Canada, CANMET, 580 Booth Street, Ottawa, Ontario, Canada K1A 0E4.

[4] Didier Thevenard, THE RETSCREEN MODEL FOR ASSESSING POTENTIAL PV PROJECTS, Numerical Logics Inc., Waterloo, ON, Canada Gregory Leng and Sylvain Martel CANMET Energy Diversification Research Laboratory (CEDRL), Varennes, QC, Canada PV Horizon: Workshop of Photovoltaic Hybrid Systems, Montreal, September 10, 2001, http://www.web.co.bw/sib/retscreen_article2.pdf.

[5] http://www.retscreen.net/ang/home.php

[6] http://www.rearch.umn.edu/downloads/Part6.pdf

[7] http://www.fotovoltaica.com/sdeinf1.pdf

[8] Jeff S. Haberl, LITERATURE REVIEW OF UNCERTAINTY OF ANALYSIS METHODS (F-Chart Program), August 2004, Texas Engineering Experiment Station, Texas A&M University System

[9] Tarek Bou-Saada, Advanced DOE-2 Calibration Procedures:A Technical Reference Manual, 1997 Texas Engineering Experiment Stati