Web-based Green House Laboratories

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ABSTRACT: *Green house effect and green energy play a vital role in society. Laboratories can able to function using green energy in a web-based environment. The proposed web laboratory generates green energy which has a well-developed metrological system. Real-time data is solicited by the laboratory and possess weather characteristics and can able to produce electricity also. This process will result in the saving of the green-house gases.*

1. Introduction

In the beginning of 2010 already act lots of international agreements, which charge most of the countries with national indicative goals to reduce the greenhouse gas (GHG) with concrete values. The final goal of the world forces is to oppose the global heat with reaching of the determined concentration of the greenhouse gas in the atmosphere and stabilizing of this proportion for possible longer period of time.

The Kyoto Protocol determines the six GHG emissions with the increased concentration in the atmosphere accelerate global warming. The targets apply to the four greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), and two groups of gases, hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) aswell as sulfur dioxide (SO_2). The six GHG are translated into CO_2 equivalents in determining reductions in emissions. For comparison of the different GHG their different force to accelerate the global warming Intergovernmental Panel on Climate Change (IPCC, 2007) create index called "global warming potential" (GIP).

The Protocol defines three "flexibility mechanisms" that can be used by Annex I Parties in meeting their emission limitation commitments. The three mechanisms are: Clean Development Mechanism (CDM), Joint implementation (JI) and International Emissions Trading (IET). They help investment in new technologies, ecology equipment and modernization of the

energy sector. Clean Development Mechanism (CDM) is pointed to countries accepted the concrete commitments for reducing GHG emissions. Often the project under CDM is connected with activities for installation of renewable energy sources.

Increasing the use of the renewable sources in global scale is on the way for decreasing the consequences of the problem.

In Bulgaria, sector "Energy" the biggest part of GHG emissions has burning processes for the production energy – 68% of the emission total in the sector. During 2010 this observed the increasing of the GHG emissions with 2159.4 Gg CO2 - equivalents compared with 2009. European Emissions Trading scheme trade is Mechanism for limitation the volume of the GHG emissions. The system allows to trade which guaranties that the common emissions are kept under the limited value. The energy, generated from photovoltaics could be accepted as ecology pure. The building of Burgas Free University has its own PV – system.

That is way it can be certified with "white certificate". This document ratified reducing of the energy consumption, which is reached by enterprises (energy producer, suppliers or distributers) in the energy market. In conception with direct connected conception for emission trade, this certificate must guaranty that the common goal for energy economic is reached. The emission factors are coefficients, which determine the quantity of emission for unit activity.

Examples for such factors are: quantity carbon dioxide emitted per MWh in consumption of petroleum fuels[tCO2/MW fuel], in consumption of electrical energy [tCO2/MW electrical energy], or consumption of thermal energy [t CO2/MW heat]. The "standard" emission factors, determined by IPCC, cover all emission of CO2, caused by electricity consumption – burning of fuels for electrical energy, thermal energy, for cooling. They are based on the carbon content of each fuel type, on the base of which determines the emission of greenhouse gases. Carbon dioxide is the most important greenhouse gas [1-4].

2. Web Based Laboratory for Production Green Energy for Education

For the needs of the educational process in Burgas Free University (BFU) the system for production of green energy is built. The idea is the students to receive necessary knowledge and skills in the area of the technologies used in renewable energetic. Important moment in their education is the possibility for estimation to assess whether technology used allows the reduction of harmful emissions. The system has possibility to investigate the dependence - pollution panels - work efficiency - emissions safe.

The base elements of the system are:

• 16 polycrystalline PV - panels with 3800 Wp power for electrical energy production;

• 6 polycrystalline PV-panels with 1100 Wp for experimental investigations, related to providing energy.

• Inverter – type IBC Serve Master 3300 MV; PV input 450 VDC, max 2×10 A; 100-350 VDC MPP; Output 230 VAC, 50 Hz, Class I, 3300 W/3600 W, 15,5 A_{max}.

The system is completed with meteorology station – BFU METEO – the system for monitoring parameters of sun radiation, the ambient temperature and wind speed, which gives possibility to receive and store data for parameters from the sensors, as well as the produced electrical energy for every 5 minutes [5].

The system consist with: power supply - 12V DC, 1; module for data storage Fronius Datalogger Web; module for sensors connections Fronius Sensor Box; sensor for wind speed Fronius Wind speed Sensor; sensor for sun radiation.

For goal a more effective processing and analyzing of the data received from the system the software package "Meteo" is developed with the next software applications.

2.1. Created Software Applications QMeteoLogger
The program QMeteoLogger is created, which periodically reads the status of the sensors and write the data in one or more data base. For this purpose Access 8 MySQL are used. It is the main instrument for data recording. The program opens the window from which the initial data from meteorological station are presented.

The program calculates and the saved emissions are introduced into two data bases. Using of two databases has a goal

storage of the information the problem with one of them.

Figure 1 shows the algorithm of created program. The first block realizes connection the data logger to QMeteoLogger. For this purpose data conversion program from a text in a format suitable for database - creates tables with columns time/value. This is realized with the second block. The third unit records in databases.
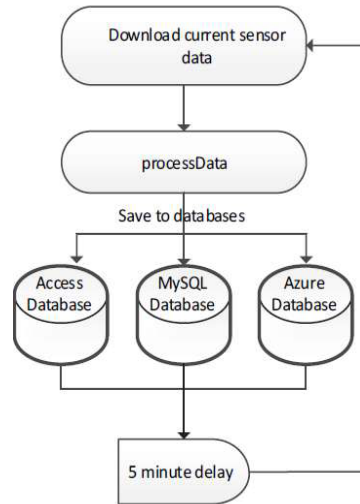

Figure 1. Main algorithm QmeteoLogger

The whole scheme/algorithm repeats periodically for five minutes.

With the help of this program realized connection with data logger, and for this purpose there is transformation of data for the program from the text to format suitable for database – creation of tables with columns – time/value. The data are rerecorded and the algorithm repeats periodically in five minutes.

The connection with the local Access BD is done with the use of Open Database Connectivity (ODBC) driver and OLE DB interface for JET storage (standard for OC WINDOWS).

The main database is on a local MySQL server in Burgas free university, the reserve is a local Access database. It exists and third Microsoft Server database to removed Azure server [7].

2.2. Created Software Applications Meteo.Logger AccessViewer and Meteo.Logger. MySQLViewer
With the help of this program the access is performed to the archived values in the database and allows outputting values of the parameters from the meteorological system in the same program and in Excel file.

The program displays and graphics for the observed parameters for determinate periods of time. It is possible and writing of data in Access database.

The link is added for taking of the reserve copy of Access database. The difference between AccessViewer and MySQLViewer is only on the type of the opened database.

Figure 2 shows the algorithm of Meteo.Logger.AccessViewer and Meteo.Logger.MySQLViewer.

The description of the algorithm includes:

• Creating of new database using already existing. Every open period of time can be recorded as a new Access database;

• Opening of database. The process of opening is done using of Open Database Connectivity (ODBC) driver and OLE DB

interface for JET storage. The opened Access tables are stored in the operation memory. This allows their fast and following manipulation before to be written in database. For MySQLViewer is used MySQL driver;
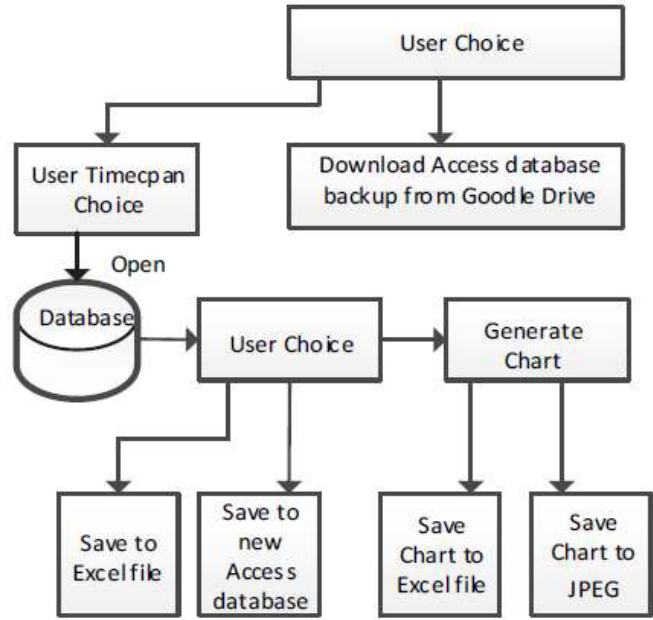

Figure 2. Main algorithm of Meteo.Logger.AccessViewer and Meteo.Logger. MySQLViewer

• Display period database. The period is loaded into memory and then displayed in tabular form. After this process the data can be recorded in a new database or Excel file recording of period in Excel file. The additional possibility is to add of graphics in Excel file;

• Recording of period in new database. This allows creating of several smaller working databases from one bigger. It is possible to be used for other purposes for treatment of the received information;

• Withdrawal of the last reserved copy of the Access database from Google Drive. This function allows for every one with the help of Access Viewer to draw the last reserved copy of database;

• Output out the graphic for the chosen period. The possibility is created to picture the changes of the parameters for years, months, days. From the table the graphic is generated which is chosen in giving of the command for imagination of the period.

• Output complex graphic. There is possibility for creation of complex graphic for chosen periods of time and data table.

2.3. Creating the Program for Determination and Visualization of the Saved GHG Emissions
Determination of the saved emissions of CO2 in production of electrical energy using alternative source makes using of an equation:

$$E = (Q_{pr}f_i)\,/1000(kgCO_2) \tag{1}$$

• Qpr – Saved electrical energy from renewable energy source (PV-panels (kW/h);

• fi – etalon value of the coefficient of the ecology equivalent of energy sources and energy $g\ CO_2/kWh$). For electrical energy for $CO_2\ fi = 683\ g\ CO2/kWh$ [2].
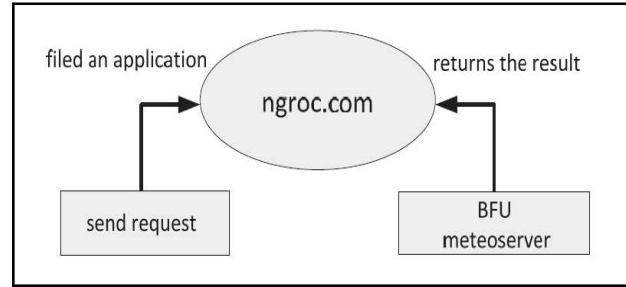
Figure 3. Web services for meteorological data

On the base of data for the emissions in production of electrical energy from thermal centrals using local lignite coils empiric dependences are done and the etalon values are determined as follows: $fi = 0,0007$ g NOx/kWh, and for sulfur dioxide - $fi = 0,0035$ g SO2/kWh.

For the possibilities to be determined and visualized saved emissions in the time of producing of electrical energy from renewable source the web services were created for meteorological data (Figure 3).

The server software is written in Service Stack (software package for the C #) and executed on the server of BSU.

The characteristics of the server are: computer ACPI x64- based PC; Operating System Microsoft Windows Server 2012 R2 Datacenter; Internet Explorer 11.0.9600.17416 (IE 11.0.14); 4096 MB system memory. It exists and second MySQL database for removed server.

The written services read database end return specified in the application scope and type of data.

This includes archival and current data from the sensors and data for saved emissions.

In the fact of the lack of open port to the server (lack of direct access to the server) the tunneling service *ngrok* (ready product accessed in the Internet), which automatically fall if there is present one.

In Figure 4 archival data for production of electrical energy from PV panels from 04.04.2017 are shown.

2.4. Creating of Mobile Application for Real Time Data Visualization MeteoRealtimeApp
For the goal of increasing for receiving of information the application was developed, which derives data in real time from the sensors using FTP server for mediator. Data are in text format. The application is presented for Windows, Linux 8 Android. Meteo - server read data from meteorological system and suspends them in FTP server. The program reads text data from FTP server, decodes and visualizes.

2.5. Creating of Website of Meteorological Station in Burgas Free University
The web site with the help of ASP.NET packet for web page and C# for part of the server component is done (Figure 5) [8].

ASP.NET packet is in accesses for students free of charge via portal Dreemspark.

With this package get the data from the meteorological station stored in a database located in a server of Microsoft.

These data are sent to the graphical interface of the site.

To create a site used Bootstrap - software for styling sites based on HTML/CSS. The site is available at http://bsmeteo.azurewebsites.net/index.aspx.

Web page supports the following functions:
• Displays current data on air temperature, wind speed, sun radiation and the production of electricity;

• Displays current data on emissions saved the carbon dioxide, sulfur dioxide and nitrogen oxides in the production of electricity with photovoltaic plant.
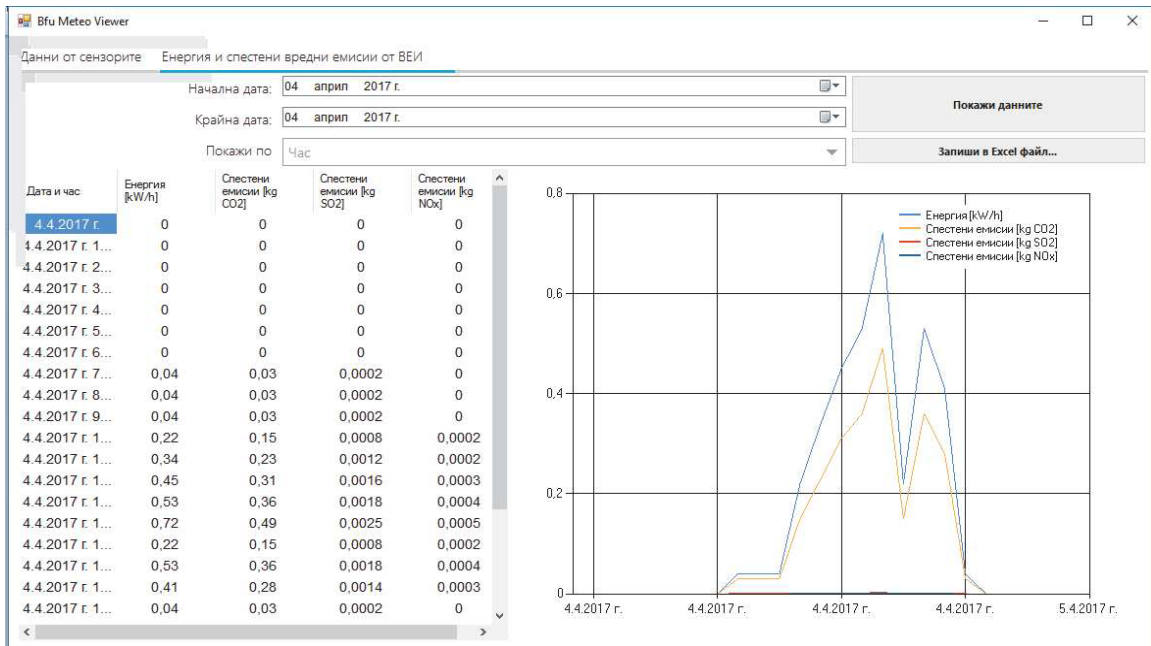

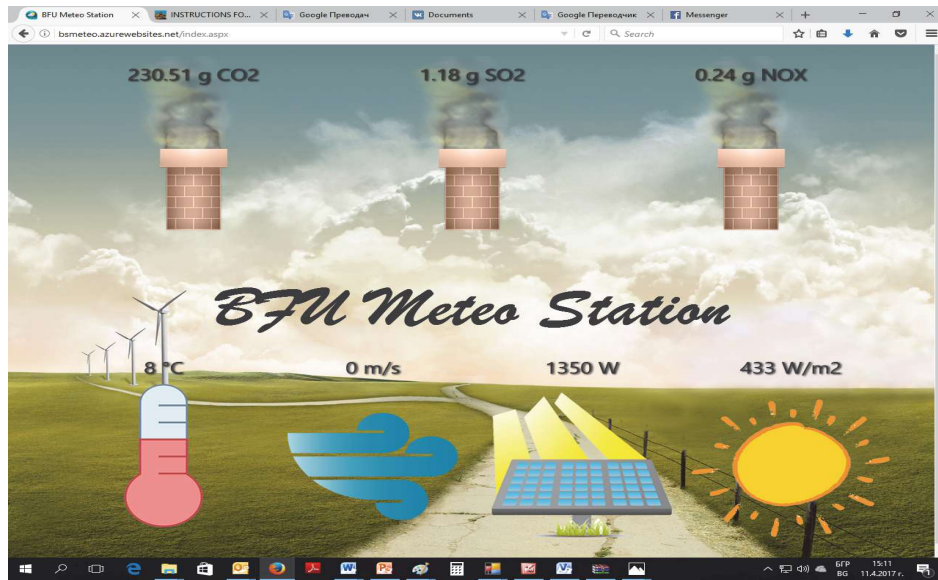Figure 4. Data saved emissions and graphic for the production of electricity from photovoltaic panels

Figure 5. The web site of meteostation

2.6. Practical Results

As a result of introducing in exploitation of the created program application, creating database received from sensors of the system for production of electrical energy. This database is used in laboratory classes for analyzing the influence of sun radiation onto electricity production and reducing emissions. Using the dependence (1) it could be calculated and visualized saved greenhouse gas emissions. There is a work for introduction of new installations for renewable energy, which will lead to further emission reductions.

3. Conclusion

Created software applications for receiving, processing, visualization and archiving of data received from the meteorological station of BFU, as well as calculating and visualization of the saved emissions of greenhouse gases in the work of the PV plant are one good possibility for using modern information technologies in the educational process. The created site weather station gives possibility anyone to have an information in real time not only for meteorological characteristics and energy production and for saved greenhouse gas emissions. The mobile application is a good possibility in real time to give necessary information.

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