ICT Support of PV Education and PV Data Web Presentation at FEE CTU in Prague

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Abstract

The aim of this article is brief information about the status of PV education and PV data web presentation at Department of Electrical Technology at FEE of Czech Technical University in Prague. Firstly, we present the ICT educational approach that we use at our department to teach the PV, further we show the status of PV data web presentation at the present time. Finally, we will introduce our future plans and ideas.

Keywords: Photo Voltaic Data Acquisition, Photo Voltaic Education

INTRODUCTION

This article deals with a brief description of ICT support of PV education at department of Electrotechnology at CTU FEE in Prague. The ICT support is centralized around a departmental network that is a part of more extensive faculty network as shown in Fig. 1. The main parts of our ICT supports are as follows:

- Departmental web
- CTU Moodle
- Edubase
- Solarweb

Herein we will describe the aforementioned individual parts in more details.

DEPARTMENTAL WEB[1]

The departmental web is a central part or in other words "a crossroad" of our network based ICT, managerial, educational and information support that we utilized not only for PV but also for other departmental activities and teaching specializations as well.

The snapshot of home page of our departmental web is shown in Fig. 2. The central part of the home page occupies the artwork composed from many pictures of different departmental workplaces and persons.

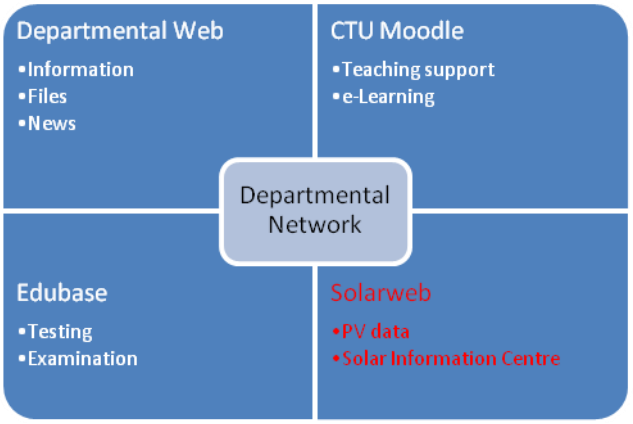

Fig. 1. The scheme of ICT tools of the department

On the left side can be seen a navigational menu which navigate a visitor to other parts of our departmental web such as calendar, contact, location, people, research groups and useful information.

MOODLE

We utilize as a main support for all courses of our department Moodle, a well known e-Learning system. The Moodle is operated by the university not by our department and it is a big advantage for us because we do not need to put our departmental resources for this and the management of Moodle is on very professional level.

[1] http://technology.feld.cvut.cz

Fig. 2. Snapshot of the departmental web

EDUBASE

Another part of our educational support is Edubase. It is a commercial client-server computer programme for student examinations. This tool is very extensionally used by our teachers in many different departmental courses including PV courses as well.

Edubase is capable very easy to examine a large quantity of students and provide the results of examination to our teachers. The alternative method of usage of this tool is the preparation of educational tests. Teachers can prepare all tests fully in Edubase and after that is possible to shuffle individual questions and print individual mutually different test. This method saves a lot of time in preparation of courses' tests.

At present time we used the client-server version of Edubase system, but we have an intention to convert to the web based version of this programme as soon as possible.

SOLARWEB[2]

The most important part of our system of ICT departmental tools is Solarweb; this part is directly targeted for PV courses support. The main goal of Solarweb is providing the date from the PV panels installed on the roof of the faculty for our students and offering the place for community communication in the field of PV education.

THE PRESENT STATUS OF SOLARWEB

The PV data acquisition (PVDA) system at Department of Electrical Technology at Faculty of Electrical Engineering of Czech Technical University in Prague is running approximately for 6 years now. It is a demonstration system targeted for educational and research activities of our solar working group. Location of our system on roof of university building is shown in Fig. 3.

[2] http://technology.feld.cvut.cz/SolarWeb

Fig. 3. The installed PV system on FEE CTU in Prague

Notwithstanding, we presented our departmental PV system on the last IWTPV seminar in 2006 year, we must again recapitulate the most important information about it. The departmental PV system FVS 2003A was installed at 2002 year on the roof of our faculty. The system is build up from 3 independent subsystems (@1kW). Each subsystem consists of 10 PV panels. The PV system is connected to the standard 230 V, 50 Hz power supply network. All produced energy is consumed at faculty building.

We collect following data from before mentioned PV system:

- sum of energy,
- direct-current voltage of panel A(inclination 45°),
- direct-current current of panel A(inclination 45°),
- direct-current voltage of panel B(variable inclination),
- direct-current current of panel B(variable inclination),
- direct-current voltage of panel C(inclination 90°),
- direct-current current of panel C(inclination 90°),
- momentary performance supplied to grid (Pac),
- panel temperature,
- intensity of incident sun radiation (Irrad).

The information from PV panels is saved in data logger ("*Sunrise*") memory approximately for 90 days. The duration of preservation of PV date in data logger depends on the size of internal memory. The information from data logger, which is located immediately under the roof, is transferred to the client workstation by RS485/RS422 proprietary cabling. We used two special cables, one with data logger data and another with additional information about PV field temperature and incident radiation intensity. The overall scheme is shown in Fig. 4.

THE INTERNET CONNECTIVITY

Towards the end of the 2005 year was installed a new data logger with standard (RS485/RS422) and a new IP (Internet) based connectivity. The standard data acquisition remains the same, but for a new IP based connectivity was necessary to prepare a new method for data acquisition. The concept of present time IP based data acquisition method needs a slightly better explanation because is a little bit tricky. The data from data logger are transmitted to the specific web server by the usage of the GET HTTP command. It means, the data are transmitted as parameters of the GET command, which take an HTML page from the specific web server on Internet. Of course, the data returned by the GET command are completely ignored, because this command is used not for reading data from arbitrary web site on Internet, but for

sending data from the data logger as parameters of this command. It means; the gathered data cannot be read from the data logger in reality.

The IP address of target web server (receiver of data) is configured into the data logger (transmitter) by the use of the special hardware from a PV system supplier. It is not a very comfortable way, because an ordinary PV system user has no possibility to change this IP address. At present time we are sending our data to CZREA (Czech Renewable Energy Agency) web server and this data are resent from CZREA to our departmental web server exactly by the same manner as we send this data to him. This method creates a possibility for a future change of the target web server location from CZREA to our departmental web server. The scheme of the present time acquisition of PV data is shown in Fig. 5.

The works on the new automated graphical presentation and processing of PV data in the context of our new Internet based connectivity was successfully finished in 2007 year. This works was covered by one master's thesis conducted by the author of this article and the results of this work are shown in the concluding part of this article.

The present time solution has many advantages:

- All data are presented on well-arranged diagrams.
- It is possible to show daily, monthly or yearly data behaviours diagrams.
- The web site system is not only presentation tool, but full-featured content management system (CMS).
- The whole system has modular structure, suitable for future expansion.
- English and Czech version exist with possibility to outreach by other languages.

Disadvantages of contemporary solution:

- Dependency on the CZREA web server.
- Impossibility to easily change the address of the target (receiver) web server.
- Impossibility to obtain historical data from the data logger.

The third item must be explained in more detail. Because the data transmission is initialized by data logger and not by a receiving client, all data transmitted in the time when the receiving client is not working are lost! It is not possible to send a request for resending of the lost data. It is a very unpleasant problem, because the data are used not only for a graphical presentation, but also for a scientific processing.

DETAILED DESCRIPTION OF "SOLARWEB"

The picture of the home page of our Solarweb system is shown in Fig. 6. It is possible to see, that the whole system contents 5 main parts:

- Solar panel – is targeted for presentation of gathered PV data.
- Articles – is a part of CMS targeted for publishing of articles with solar energy subject matter.
- Discussion – is a part of CMS targeted for free discussion about solar energy subject matter.
- Files – is a part of CMS targeted for file upload.
- Links – is a part of CMS targeted as area of useful links to other web sites relevant to solar energy subject matter.

The layout of presentation page with gathered PV data of output energy for one concrete day is shown in Fig. 7. We can see on left side of the picture a calendar element targeted for choosing a datum. On bottom part of the picture is located a bar with buttons targeted for choosing a gathered variable we want to show. The alternate variant of this page showing the data in tabular form is shown in Fig. 8. The monthly data are shown in Fig. 9. and finally a yearly data are shown in Fig. 10. In addition, the integrated CMS system facilitates the community role of our Solarweb system.

The most problematic part of our Solarweb system is a viability of CMS. Our experts now have a possibility to publish articles, conduct discussions or fill up our system with useful links to other sites with PV subject matter.

CONCLUSION - FUTURE AND IDEAS

We have some ideas and objectives for our subsequent work. Firstly, we want to fill up our CMS with useful

articles and links. Further, we want actively conduct discussions and finally, we need to integrate a processing of our PV data with meteorological data collected by the Department of Telecommunications Engineering of our institute. Our strategic goal is to create a complex information system about the photovoltaic education, e-Learning and research.

ACKNOWLEDGEMENT

This research (work) has been supported by Ministry of Education, Youth and Sports of Czech Republic under research program MSM6840770017

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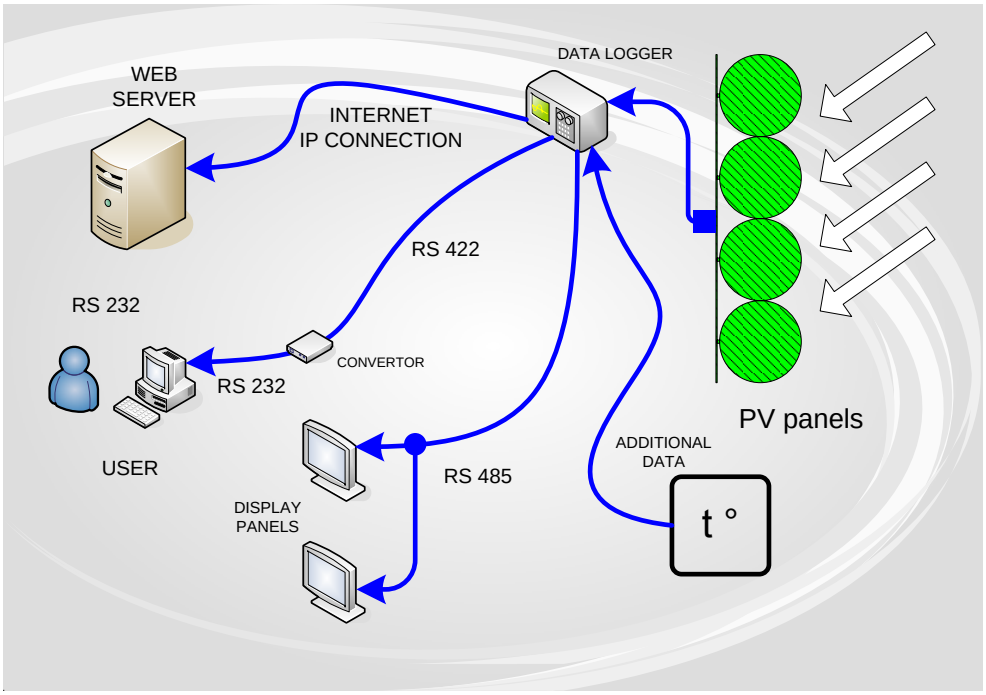


Fig. 4. Present time network topology.

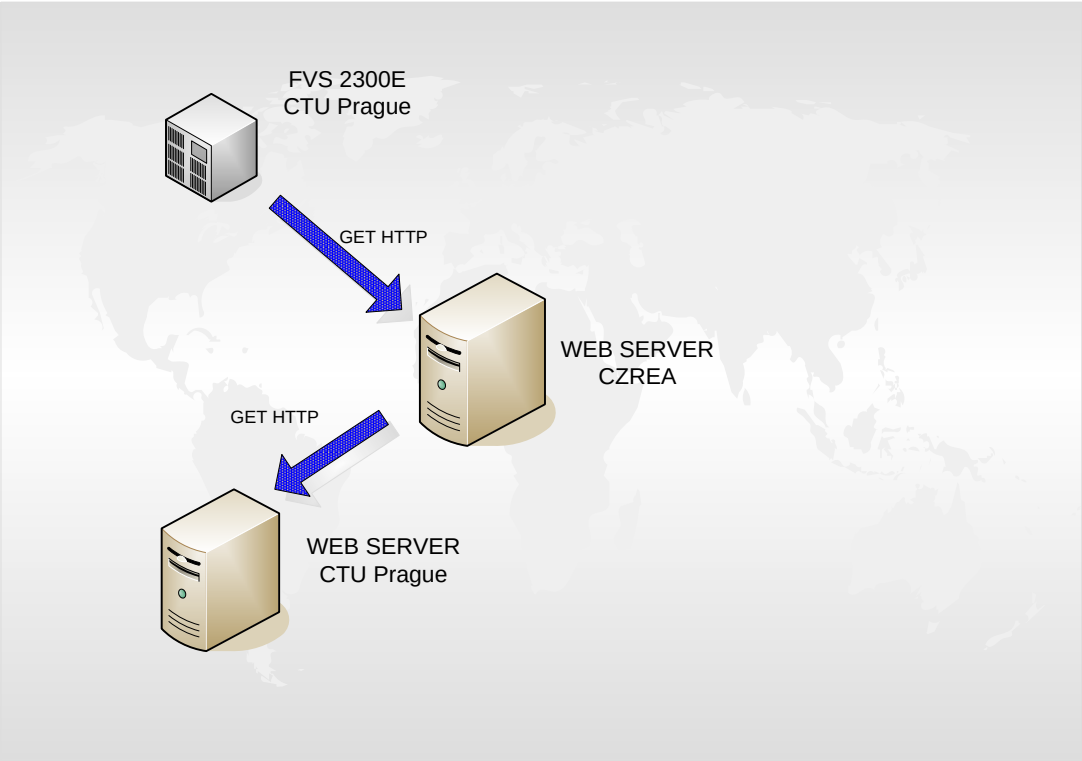


Fig. 5. The scheme of Internet transmission of PV data.

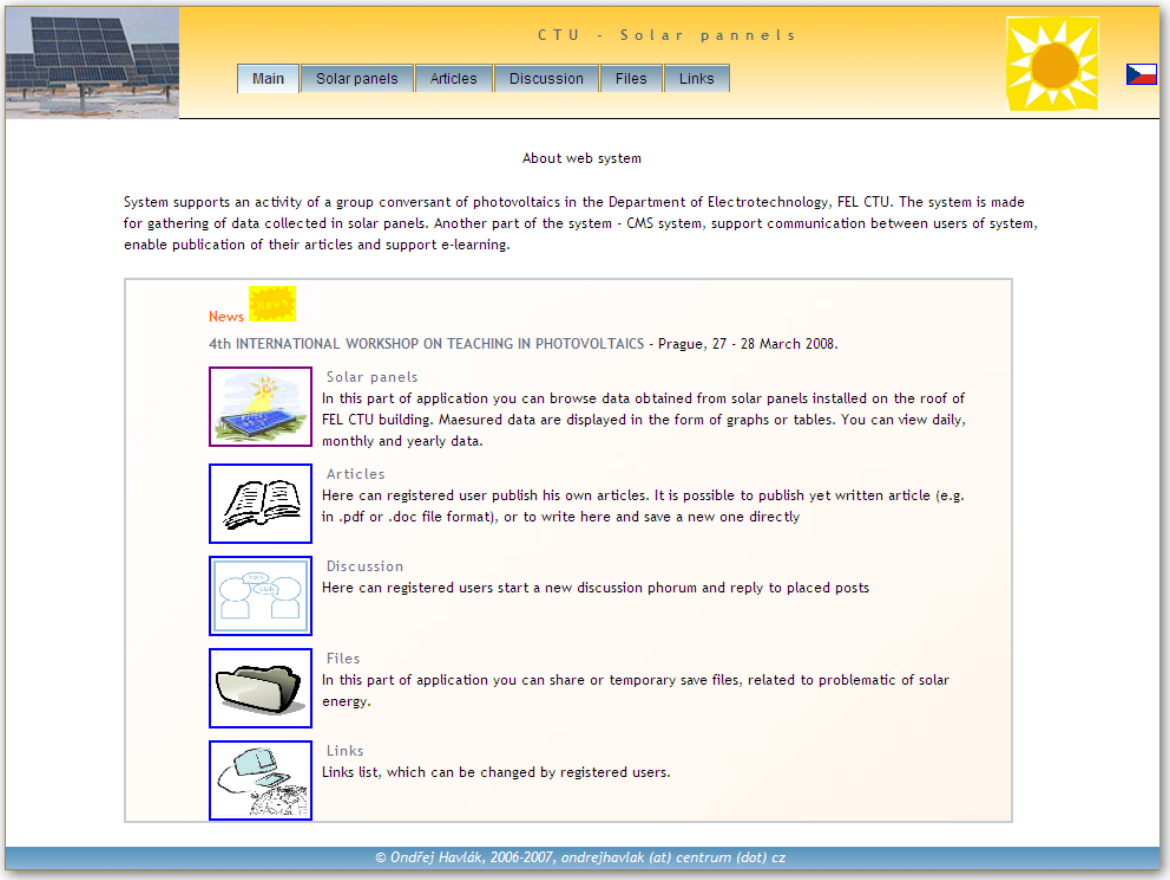


Fig. 6. Solar Web Home Page.

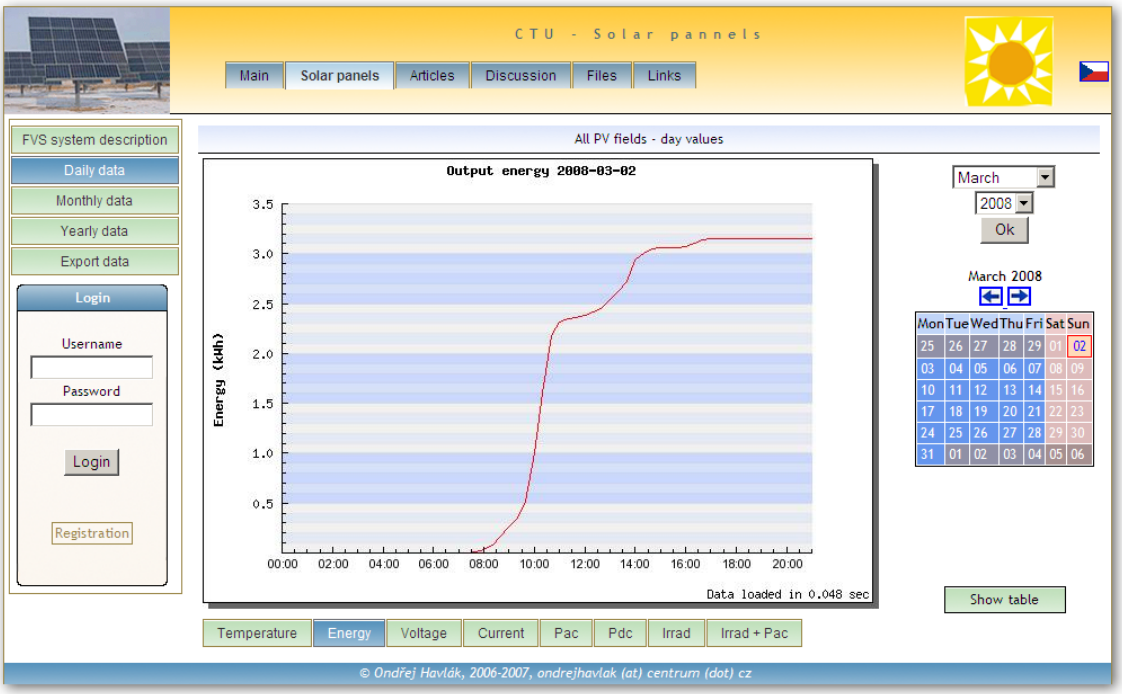
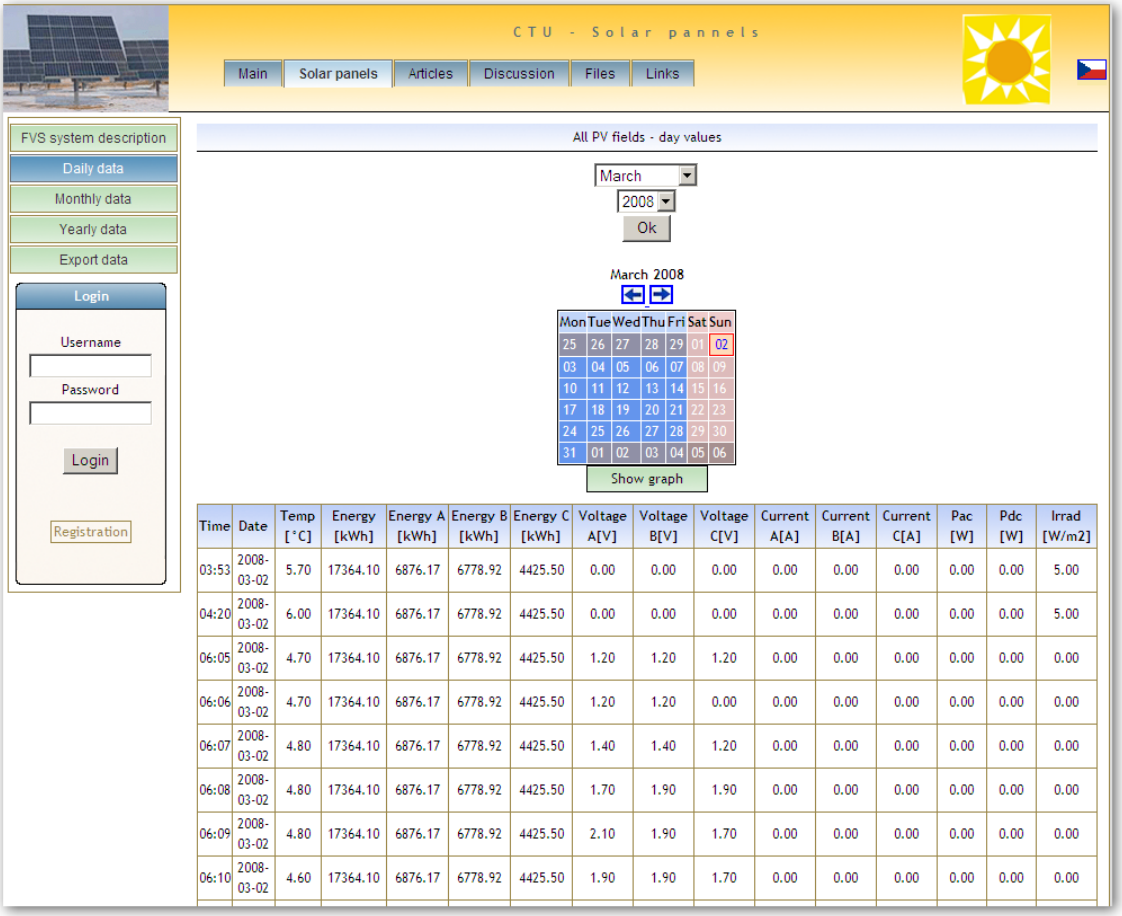


Fig. 7. Graph of output energy (daily).



Time	Date	Temp [°C]	Energy [kWh]	Energy A [kWh]	Energy B [kWh]	Energy C [kWh]	Voltage A[V]	Voltage B[V]	Voltage C[V]	Current A[A]	Current B[A]	Current C[A]	Pac [W]	Pdc [W]	Irrad [W/m2]
03:53	2008-03-02	5.70	17364.10	6876.17	6778.92	4425.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
04:20	2008-03-02	6.00	17364.10	6876.17	6778.92	4425.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00
06:05	2008-03-02	4.70	17364.10	6876.17	6778.92	4425.50	1.20	1.20	1.20	0.00	0.00	0.00	0.00	0.00	0.00
06:06	2008-03-02	4.70	17364.10	6876.17	6778.92	4425.50	1.20	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06:07	2008-03-02	4.80	17364.10	6876.17	6778.92	4425.50	1.40	1.40	1.20	0.00	0.00	0.00	0.00	0.00	0.00
06:08	2008-03-02	4.80	17364.10	6876.17	6778.92	4425.50	1.70	1.90	1.90	0.00	0.00	0.00	0.00	0.00	0.00
06:09	2008-03-02	4.80	17364.10	6876.17	6778.92	4425.50	2.10	1.90	1.70	0.00	0.00	0.00	0.00	0.00	0.00
06:10	2008-03-02	4.60	17364.10	6876.17	6778.92	4425.50	1.90	1.90	1.70	0.00	0.00	0.00	0.00	0.00	0.00

Fig. 8. Table of output energy (daily).

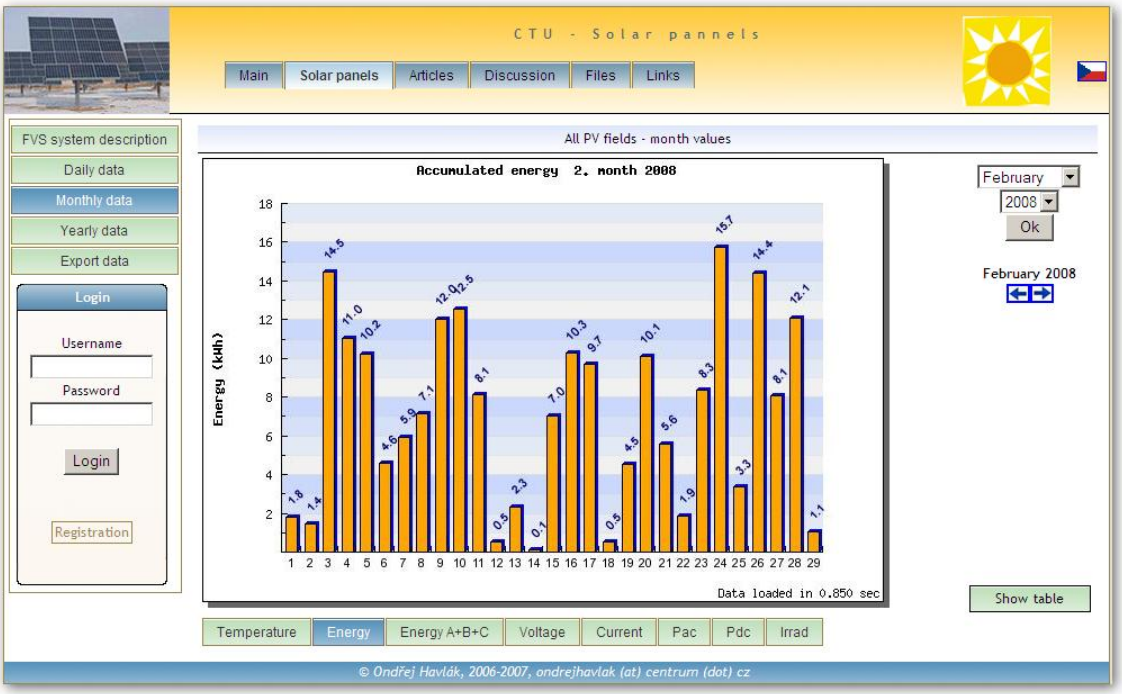


Fig. 9. Graph of accumulated energy (monthly).

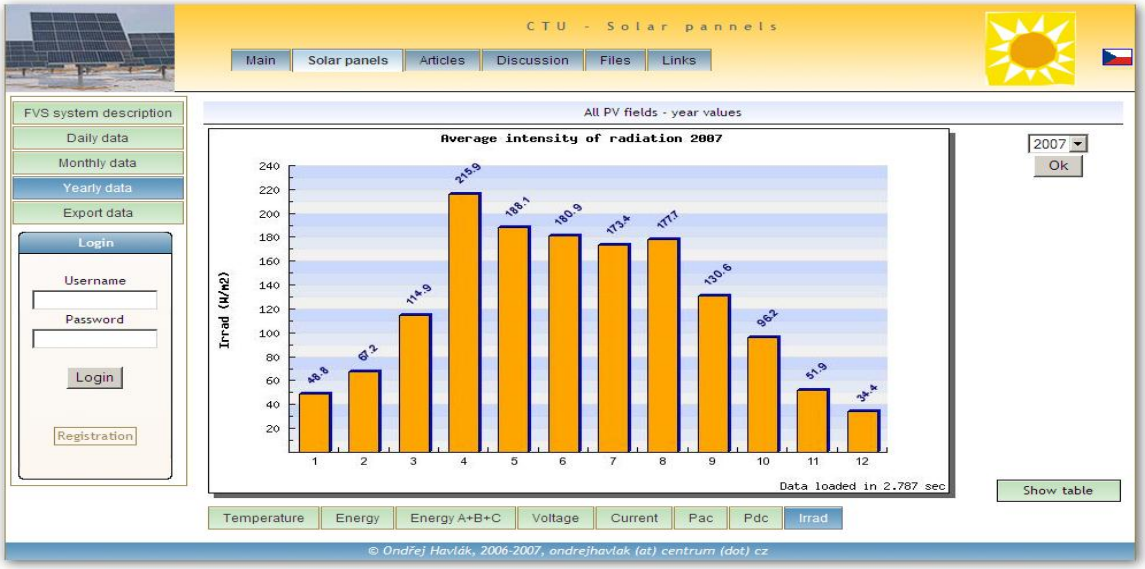


Fig. 10. Graph of intensity of radiation (yearly).