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	Department: Informatik


DIPLOMA THESIS

Documentation

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Topic	AEMS – Advanced Energy Monitoring System
Co-operation partners	Energiegenossenschaft Region Eferding

Assignment of tasks	<p>Development of a bot which extracts data from AMIS-meters and stores it in the database of the AEMS-System.</p> <p>Define customized meters for instance electricity-meters, heat-meters and many more and set them up on your personal Raspberry-PI.</p> <p>The entirety of data will be processed and displayed as statistics. Furthermore the generation of reports which specify time constraints are possible as well. The aforementioned functionalities also provide download capability.</p> <p>Additionally the detection of anomalies is provided by an integrated scripting language called AEMS-scripting-language (AEMSSL). The main aim of the scripting language is the detection of deviation of consumption values either caused by meters themselves or sensors affecting the meters values (day-time, light-intensity).</p> <p>Moreover an integrated notification system supports easy recognition of abnormal meter data.</p> <p>Development of an android-app to display priorly defined and generated statistics. The android-app also comes along with the download capability of statistics and notifies the user if abnormal meter data is noticed by the system.</p> <p>Administrative tool for the management of access rights to the system.</p>
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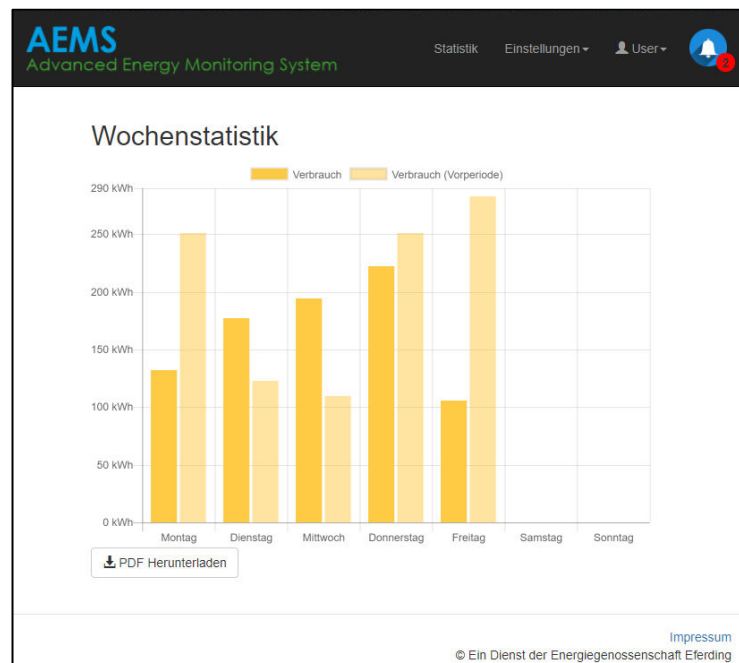
Realisation	<p>Android app development was supported by the IDE Android Studio V.2.3. For the generation of statistics the MPAndroidCharts library was consulted. The communication between the server and the client is managed by a REST-API as well as by a self-created library AEMS-API-LIB. Every further functionality found in the android-app was entirely self-created.</p> <p>Creation of the web-interface was supported by several libraries namely CSS, Bootstrap. Additionally modals were created by the help of clean-modal-</p>
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	<p>login-form.</p> <p>The language in which the web-interface was designed was chosen to be XHTML and was utilized in conjunction with Java-Server-Faces (JSF). Moreover jQuery and JavaScript were used to implement further functionality.</p> <p>The library which grants the display of statistics is named Chart.js And the one which provides the capabilities for downloading PDFs is named jsPDF.</p> <p>The web-interfaces supplies the user with the possibility to display the desired statistics which the user wants to have immediate access to as well as to define quick statistics. These statistics can furthermore be subject to download or configuration. Possible configuration would be to only let the statistic appear on the smartphone app or to declare time constraints on reports or statistics to only receive reviews of periods that the user demands. In Addition guidelines for the detection of anomalies can be specified which will be taken under advisement by the unit which is accountable for processing the data received from the meters and sensors (AEMSSL).</p> <p>The administrative tool was also chosen to be designed with XHTML, jQuery, JavaScript, JSF and Bootstrap. This tool permits the administration of access rights hence the declaration of new administrators and moreover to specify the exact geographical realms where the administrators operate in.</p> <p>PostgreSQL-Database as a means of data storage.</p> <p>The report-bot is in charge of downloading the data from the NETZONLINE-page which then gets stowed in the database of the system. This program was entirely implemented with the JAVA programming language. In order to had implemented the communication with the NETZONLINE-page a special library named HTMLUnit was consulted. For the extraction of the data from the excel files which were downloaded by the report-bot another library named Apache POI was utilized.</p> <p>A Java REST-API enables the communication between the database and the several clients. The aforementioned REST-API provides a logical layer for all database requests performed via GraphQL to guarantee a never changing communication protocol.</p> <p>With the utilization of a Raspberry PI the data of various different meter types is able to be read from. After the read the data is transmitted to the database via the REST-API which then is responsible for creating the proper SQL statements to store the data properly in the database. The acquisition of meter data is performed by a Plugin-System which is capable of dynamically including user-defined Plugins into the processing environment.</p> <p>In conjunction with home automation an interface to Open-HAB was established. Via this interface it is possible for the user to retrieve the current meter value from the server and to display it.</p>
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Results	Functional report-bot, which retrieves data and stores it in the database. Functional client/server infrastructure between the utilized services. Functional services are web-interface, administrative tool, android-app, Raspberry PI meter data extraction, aems-apilib, database and Java REST-API. Every functionality demanded by the customer was satisfied.
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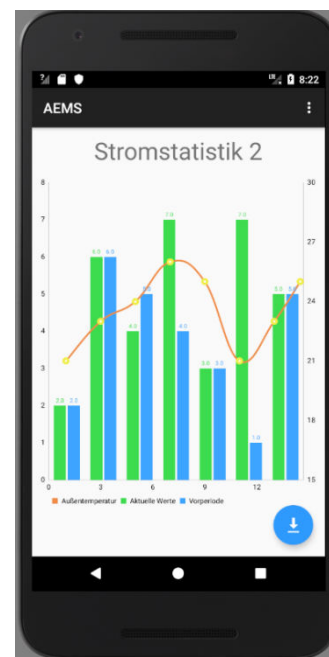
Illustrative graph, photo
(incl. explanation)



The screenshot shows the AEMS web interface. At the top, there's a navigation bar with 'Statistik', 'Einstellungen', 'User', and a notification bell. The main title is 'Wochenstatistik'. The chart is a grouped bar chart with two series: 'Verbrauch' (dark orange) and 'Verbrauch (Vorperiode)' (light orange). The x-axis lists the days of the week from Monday to Sunday. The y-axis shows energy consumption in kWh from 0 to 290. A 'PDF Herunterladen' button is at the bottom left. The footer contains 'Impressum' and '© Ein Dienst der Energiegenossenschaft Eferding'.

Tag	Verbrauch (kWh)	Verbrauch (Vorperiode) (kWh)
Montag	130	250
Dienstag	175	120
Mittwoch	190	110
Donnerstag	220	250
Freitag	105	285
Samstag	-	-
Sonntag	-	-


Dashboard. On the top one can find the navigation bar with the menus, the user and the notification system. The content of the page itself is comprised of user selected statistics which are available for download.

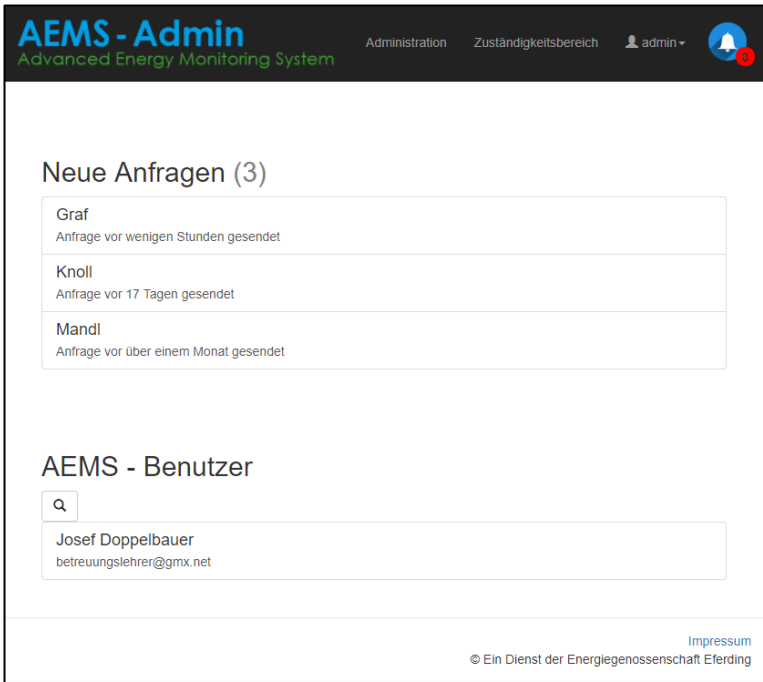


The screenshot shows the AEMS mobile app interface. At the top, there's a navigation bar with 'AEMS' and a menu icon. The main title is 'Stromstatistik 2'. The chart is a combined bar and line chart with three series: 'Außenklima' (orange line), 'Aktuelle Werte' (green bars), and 'Vorperiode' (blue bars). The x-axis shows days from 3 to 15. The left y-axis ranges from 0 to 8, and the right y-axis ranges from 15 to 30. A download icon is at the bottom right.

Tag	Außenklima	Aktuelle Werte	Vorperiode
3	3.2	6.0	2.5
4	4.5	6.0	2.5
5	5.0	4.0	2.5
6	5.5	7.0	4.0
7	6.0	4.0	4.0
8	5.5	3.0	3.0
9	5.0	3.0	3.0
10	4.5	7.0	1.0
11	4.0	5.0	5.0
12	3.5	5.0	5.0
13	3.0	5.0	5.0
14	3.5	5.0	5.0
15	4.0	5.0	5.0

View of a statistic in the android-app. On the top one can find the navigation bar which provides the functionalities of displaying the current notifications accessible by the user as well as layout changes. The view depicts a statistic with current consumption values and consumption values of the pre-period and the corresponding anomaly. Furthermore there is the possibility to download the statistics.

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		<p>The view of the administrative tool web-page. The navigation bar displays the menus accessible by the user as well as the currently logged-in user and the notification system. The content of this picture illustrates incoming request for usership. These have to be accepted in order to be viewed as a user of the system. Previously added users can be easily found by utilizing the provided search functionality.</p>

Participation in competitions Awards	<p>Bosch – Technik fürs Leben Preis 2018 Jugend Innovativ – Sonderpreis Sustainability</p> <p>Since the evaluation of the diploma is performed after the conclusion and submission of the project work to competitions no information regarding awards is present.</p>
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Accessibility of diploma thesis	<p>The source code of this diploma is subject to strict secrecy, at the wish of the project team, and is merely accessible by the commission responsible for the grading of this diploma. One version of this diploma will be stored in the archive and is subject to prohibition for public insight.</p>
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Approval (date/signature)	Examiner	Head of College/Department
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