
POLITECNICO DI MILANO



Dipartimento di Elettronica e Informazione

A demand-response feedback program for real time consumption monitoring and targeted advice

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Abstract

This thesis presents a demand-response feedback program for Real time Consumption monitoring and targeted advice. In order to improve energy efficiency, this Cassandra project is introduced. The aim is to providing shop owners with consumption feedback and targeted advice, and evaluate their impact on electricity overall consumption. The group of Professor Luca Ferrarini, Giancarlo Mantovani, Alessio Dedè and Julián Peña Flórez developed this Cassandra project, and I was lucky to be a member of this group in a period of time, mainly doing the part of mobile interface.

The basic concept is that the platform is implemented as a Java Web Service running under Apache Tomcat v7.0, installed in a server accessible to Cassandra API, connecting shop owners with this project. In this way, the users can be informed about their energy use situation and get feedback and advice about how to reduce their energy consumption.

In the end, we come to the conclusion that with this Cassandra project, the energy consumption is reduced and the efficiency is improved. There are further works can be done in the future, such like studying different control strategies for energy optimization and comfort regulations for the commercial building, which will be in the next phase of this project.

Keywords: Feedback, demand-response, Energy consumption, efficiency, Java, SQL

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1 Introduction

Because of the continuous worldwide depletion of natural resources, the price of resources and energy production are increasing faster than those of the essential goods of life. The rate at which energy prices increase is expected to become much higher than that of other resources.

There are many motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers. Reducing energy use is also seen as a solution to the problem of reducing carbon dioxide emissions. As a result of the climate change convention and the subsequent Kyoto protocol of the United Nations framework convention, regulation of carbon dioxide emissions has been imposed on each nation, which has become a strong factor in reducing energy (particularly electric energy).

According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases.

When we conserve energy resources, our nation can enjoy cleaner air and a healthier environment, and we can help protect the climate by reducing greenhouse gases. Even though energy conservation reduces energy services, it can result in increased, environmental quality, national security, and personal financial security. It is at the top of the sustainable energy hierarchy

1.1 The Problem

The environment is in the shopping center named as Campo dei Fiori. The goal is to measure the thermal loads of the common parts and the electrical consumption of different shops. And try to reduce energy consumption using targeted advices and different ways.

We want to understand the response of different types of shops to real time consumption feedback. The real-time consumption data will help us get a hindsight into electricity consumption reduction at different times of the day for different types of shops. With those different consumption profiles, we can design advice and messages relevant to those shops and then measure the additional impact of targeted positive messages.

1.2 The Solution

CASSANDRA PLATFORM: A DEMAND-RESPONSE FEEDBACK PROGRAM FOR REAL TIME CONSUMPTION MONITORING AND TARGETED ADVICE

All over the world there are very few examples of demand-response feedback program in the commercial and retail sector. Which we did is an innovative feedback program for shop owners and building managers and it can realize demand-response and energy efficiency in commercial buildings,

In particular shop owners are provided with a system allowing the real-time monitor of their power consumption, enhanced with KPIs. The same interface is given

to building managers in order to control the common spaces electrical consumptions.

The interface contains information about historical consumption data (monetary, CO2 emissions, KWh), peer comparison (between similar shops) and real time information (monetary, CO2 emissions, KWh). The interface contains even information on targeted advices related to energy performance and comparison with similar shops.

1.3 Thesis structure

The thesis is organized in five sections. The second section provides a description of the software architecture, data model and frameworks used in the Cassandra project. The third section describes the web-interface connecting the customers with the program. The fourth section shows the procedure how the Cassandra project was implemented involving shop owners. The last section is the conclusions and what can be done in the future work.

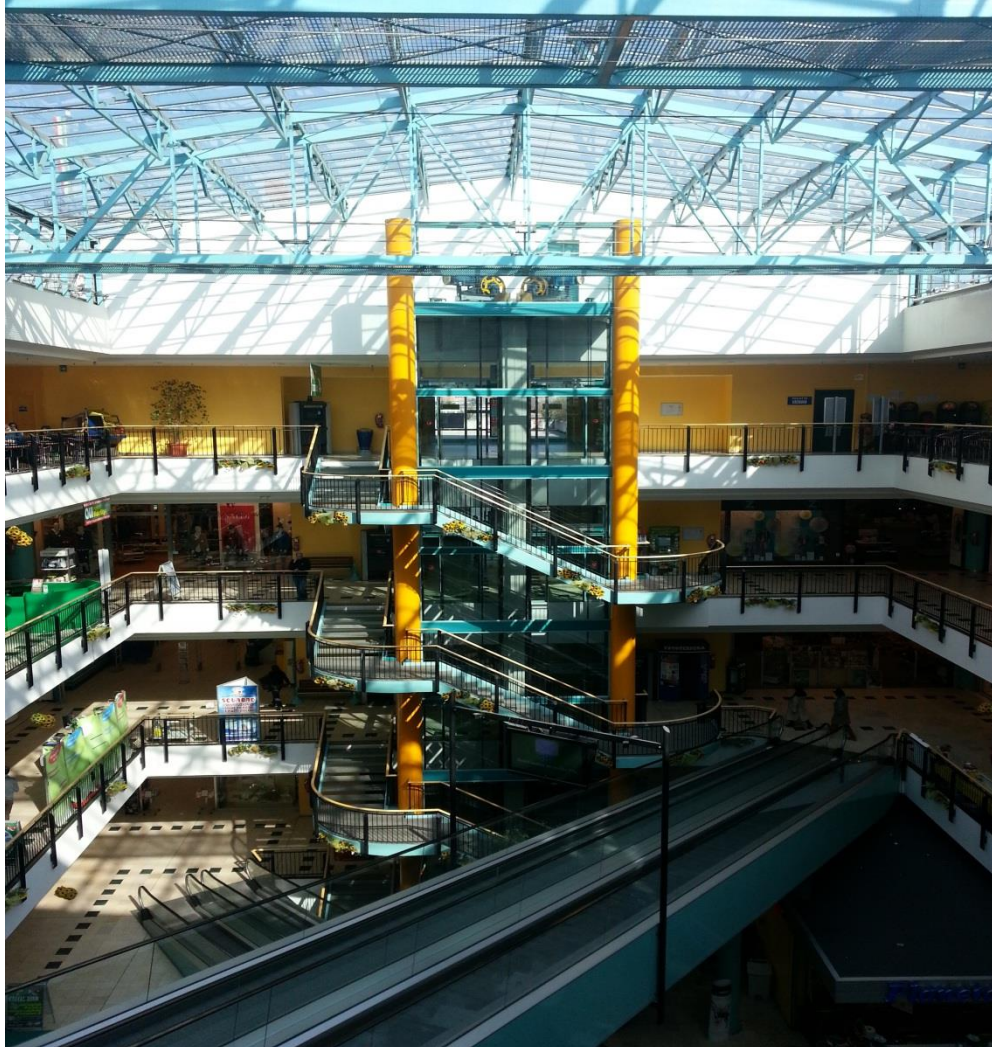
2 Casandra project

The project is implemented in the environment of a shopping center named as Campo dei Fiori. With the web-portal interface connecting users, we measure the energy consumption of different shops, and through giving feedback or targeted advices, we increase the energy efficiency.

The basic concepts about the platform are implemented as a Java Web Service running under Apache Tomcat v7.0, installed in a server accessible to Cassandra API, with interfaces giving necessary information and advices.

2.1 Environment introduction

The commercial building Campo dei Fiori is divided in five floors, where the first and a part of the second are under ground, while the other three are instead above ground. The first level has stores and a fitness area with a private gym and swimming pool, floors from two to four host mainly retail shops and a Carrefour supermarket, while level five has a restaurant. The distinguishing feature of the building is that from level two to five, in the middle of each floor, there is an open area. The open central area has a glass cover which allows natural lighting all over the year.



Shopping center, Campo dei Fiori

At Campo dei Fiori shopping center, there are two main thermal actuators types for the common parts. The first is the air-handling units for primary air supply. There are other smaller air-handling units operated by the supermarket, the restaurant and the swimming pool. The second type of thermal actuator installed in the centre for temperature control is the fan-coil. Fan-coils in the building are installed both in the common parts and in the shops.

2.2 System architecture

The basic idea is to have a web server available for Cassandra API, which is implemented as a Java Web Service running under Apache Tomcat v7.0, according to the program design specifications

The architecture chosen for the web portal is a classical approach for web application. It has the following main components:

Apache Tomcat web-server: where the application is deployed.

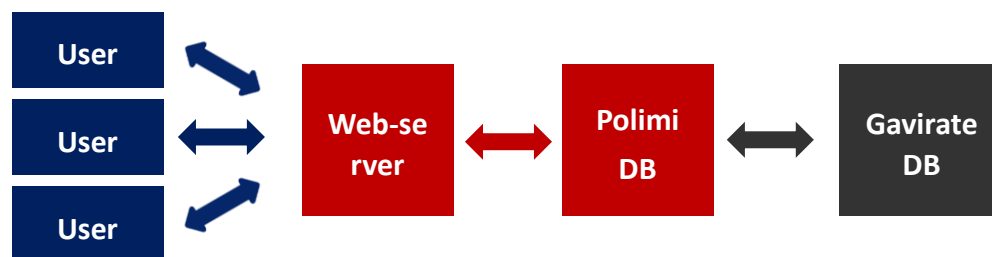
Java web-services for:

Connecting to the database

Perform all the necessary backend activities and calculations

MySQL database, which contains all the necessary information for a correct operation

HTML interface, connected to the Java web-services



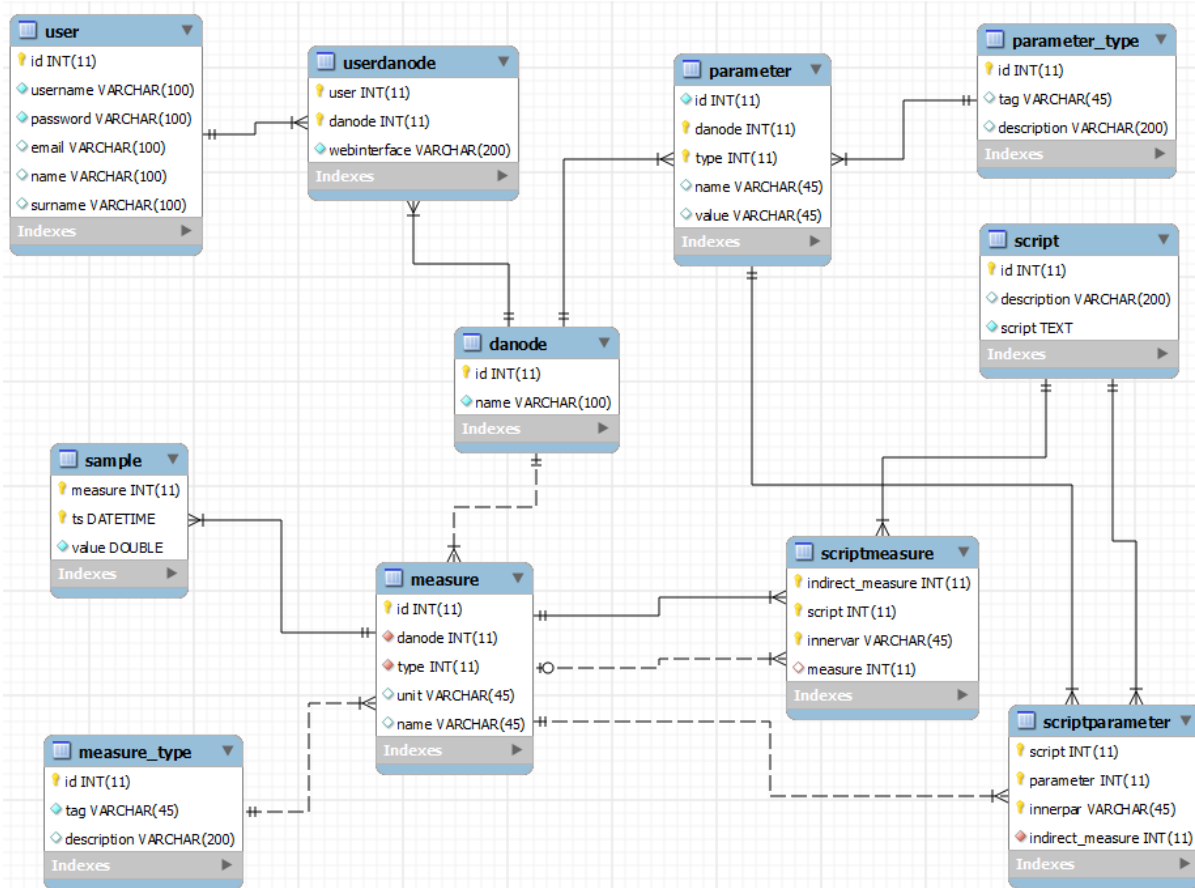
System architecture

In parallel to the web application, a Java daemon application was developed in order to retrieve data in real time from the shopping center BAS database. Data is updated every minute and is immediately available to the web-portal user.

2.3 Data model

The core of the system is the data-model, whose E-R diagram is shown in the figure below. There are several tables which allow a complete management of all the relevant information.

Each shop is a danode (data acquisition node). Each danode has a set of associated parameters (like surface or number of employees and all parameters necessary to the calculation of quantities shown in the portal).



Database structure

Each danode has a set of associated measures. Measures can be direct (i.e. have a set of associated samples, like active power) or indirect (like daily or monthly energy consumption, are calculated starting from direct measures). Indirect measures can be calculated using scripts, which can be evaluated at runtime, and which use both a set of measures and a set of parameters. For example the monthly energy consumption per square meter is associated to each shop's monthly active power consumption (direct measure with samples) and associated to each shop's surface (a parameter).

This system allows a flexible parameterization of the system, with the possibility to add further quantities or KPIs to be shown to the portal users with a very low effort.

2.3 Frameworks used

Some frameworks in java are used in this Cassandra project presented here, in order to better implement the project, making the procedure more efficient, which will be detailed introduced about their functions in this section, to give a clear, comprehensive and detailed view of this whole platform,

Spring framework:

The Spring Framework is an open source application framework and inversion of control container for the Java platform. The framework's core features can be used by any Java application, but there are extensions for building web applications on top of the Java EE platform. Although the framework does not impose any specific programming model, it has become popular in the Java community as an

alternative to, replacement for, or even addition to the Enterprise JavaBean (EJB) model.

The Spring Framework provides a comprehensive programming and configuration model for modern Java-based enterprise applications - on any kind of deployment platform. A key element of Spring is infrastructural support at the application level: Spring focuses on the "plumbing" of enterprise applications so that teams can focus on application-level business logic, without unnecessary ties to specific deployment environments.

Features:

Dependency Injection

Aspect-Oriented Programming including Spring's declarative transaction management

Spring MVC web application and RESTful web service framework

Foundational support for JDBC, JPA, JMS

//

```
<listener>
  <listener-class>org.springframework.web.context.ContextLoaderListener</l
  istener-class>
</listener>

<servlet>
  <servlet-name>feedback</servlet-name>
  <servlet-class>org.springframework.web.servlet.DispatcherServlet<
  /servlet-class>
  <!-- init-param >
    <param-name>contextConfigLocation</param-name>
    <param-value>
      <u>classpath:*feedback-servlet.xml</u>
    </param-value>
```

```
</init-param-->
<load-on-startup>1</load-on-startup>
</servlet>

//

//

<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE beans PUBLIC "-//SPRING//DTD BEAN 2.0//EN"
    "http://www.springframework.org/dtd/spring-beans-2.0.dtd">
<beans>
  <bean id="publicUrlMapping"
    class="org.springframework.web.servlet.handler.SimpleUrlHandlerMapping"
    >
    <property name="interceptors">
      <list>
        <ref local="LoginPreHandlerInterceptor"/>
      </list>
    </property>
    <property name="mappings">
      <value>
        /index.html=indexController
        /main.html=mainController
        /shops.html=shopsController
        /shopRealTime.html=shopRealTimeController
        /shopStorico.html=shopHistoricalController
        /shopConfronti.html=shopComparesController
      </value>
    </property>
  </bean>
  <bean id="indexController" class="feedback.mvc.IndexController" />
  <bean id="mainController" class="feedback.mvc.MainController" />
  <bean id="shopsController" class="feedback.mvc.ShopsController" />
  <bean id="shopRealTimeController"
    class="feedback.mvc.ShopRealTimeController" />
  <bean id="shopHistoricalController"
    class="feedback.mvc.ShopHistoricalController" />
  <bean id="shopComparesController"
    class="feedback.mvc.ShopComparesController" />
  <bean id="viewResolver"
    class="org.springframework.web.servlet.view.ResourceBundleViewResolver"
    >
    <property name="basename" value="views"/>
  </bean>
```

```

    <bean id="LoginPreHandlerInterceptor"
        class="feedback.mvc.LoginPreHandlerInterceptor">
        <property name="LoginPage" value="/Feedback/index.html"/>
        <property name="mainPage" value="/Feedback/main.html"/>
    </bean>
</beans>

//

//

xmlns=http://www.springframework.org/schema/beans "
xmlns:dwr="http://www.directwebremoting.org/schema/spring-dwr"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:tx="http://www.springframework.org/schema/tx"
xmlns:aop="http://www.springframework.org/schema/aop"
xsi:schemaLocation="http://www.springframework.org/schema/beans
    http://www.springframework.org/schema/beans/spring-beans-3.0.xsd
    http://www.directwebremoting.org/schema/spring-dwr
    http://www.directwebremoting.org/schema/spring-dwr-3.0.xsd
    http://www.springframework.org/schema/tx
    http://www.springframework.org/schema/tx/spring-tx-3.0.xsd
    http://www.springframework.org/schema/aop
    http://www.springframework.org/schema/aop/spring-aop-3.0.xsd">

//

```

Hibernate:

Hibernate is an object-relational mapping library for the Java language, providing a framework for mapping an object-oriented domain model to a traditional relational database. Hibernate solves object-relational impedance mismatch problems by replacing direct persistence-related database accesses with high-level object handling functions.

Hibernate is a free software that is distributed under the GNU Lesser General Public License. Its primary feature is mapping from Java classes to database tables (and from Java data types to SQL data types). Hibernate also provides data

query and retrieval facilities. It generates SQL calls and relieves the developer from manual result set handling and object conversion. Applications using Hibernate are portable to supported SQL databases with little performance overhead[c

```
//
<!-- HIBERNATE -->
<!-- bean id="dataSource"
class="org.springframework.jdbc.datasource.DriverManagerDataSource" -->
<bean id="dataSource" class="org.apache.commons.dbcp.BasicDataSource"
destroy-method="close">
    <property name="driverClassName" value="com.mysql.jdbc.Driver" />
    <property name="url" value="jdbc:mysql://127.0.0.1:3306/FEEDBACK" />
    <property name="username" value="root" />
    <property name="password" value="install" />
</bean>

<!-- Session Factory da utilizzare per mapping attraverso file xml -->
<bean id="sessionFactory"
class="org.springframework.orm.hibernate4.LocalSessionFactoryBean">
    <property name="dataSource" ref="dataSource" />
    <property name="mappingResources">
        <list>
            <value>feedback/dao/data/User.hbm.xml</value>
            <value>feedback/dao/data/Danode.hbm.xml</value>
            <value>feedback/dao/data/UserDanode.hbm.xml</value>
            <value>feedback/dao/data/Parameter.hbm.xml</value>
            <value>feedback/dao/data/ParameterType.hbm.xml</value>
            <value>feedback/dao/data/Measure.hbm.xml</value>
            <value>feedback/dao/data/MeasureType.hbm.xml</value>
            <value>feedback/dao/data/Sample.hbm.xml</value>
            <value>feedback/dao/data/Script.hbm.xml</value>
            <value>feedback/dao/data/ScriptParameter.hbm.xml</value>
            <value>feedback/dao/data/ScriptMeasure.hbm.xml</value>
        </list>
    </property>
    <property name="hibernateProperties">
        <props>
            <prop key="hibernate.dialect">
                org.hibernate.dialect.MySQLDialect</prop>
            <prop key="hibernate.show_sql">>false</prop>
        </props>
    </property>
</bean>
```

```
    </property>  
</bean>  
  
//
```

Dwr:

The DWR project was started by Joe Walker in 2004. DWR, or Direct Web Remoting, is a Java open source library that helps developers write web sites that include Ajax technology. It allows code in a web browser to use Java functions running on a web server as if those functions were within the browser.

It consists of two main parts:

1. Code to allow JavaScript to retrieve data from a servlet-based web server using Ajax principles.
2. A JavaScript library that makes it easier for the web site developer to dynamically update the web page with the retrieved data.

DWR takes a novel approach to Ajax by dynamically generating JavaScript code based on Java classes. Thus the web developer can use Java code from JavaScript as if it were local to the web browser; whereas in reality the Java code runs in the web server and has full access to web server resources. For security reasons the web developer must configure exactly which Java classes are safe to export (which is often called web.xml or dwr.xml).

```
//  
<!-- DWR CONFIG -->  
    <bean id="userDWR" class="feedback.dwr.UserDWR">  
        <dwr:remote javascript="UserDWR">
```

```
        <dwr:include method="Login" />
        <dwr:include method="Logout" />
    </dwr:remote>
</bean>

<bean id="sampleDWR" class="feedback.dwr.SampleDWR">
    <dwr:remote javascript="SampleDWR">
        <dwr:include method="getSamples" />
    </dwr:remote>
</bean>

<dwr:controller id="dwrController" debug="false">
    <dwr:config-param name="activeReverseAjaxEnabled" value="true" />
</dwr:controller>
<dwr:configuration>
    <dwr:convert type="bean" class="feedback.dao.data.Sample"/>
</dwr:configuration>

//

//

<!-- DWR servlet setup -->
<servlet>
    <servlet-name>dwr</servlet-name>
    <servlet-class>org.directwebremoting.spring.DwrSpringServlet<
/servlet-class>
    <init-param>
        <param-name>debug</param-name>
        <param-value>true</param-value>
    </init-param>
    <init-param>
        <param-name>activeReverseAjaxEnabled</param-name>
        <param-value>true</param-value>
    </init-param>
</servlet>

<servlet-mapping>
    <servlet-name>dwr</servlet-name>
    <url-pattern>/dwr/*</url-pattern>
</servlet-mapping>

//
```

3 Interface of the project

The web-portal interface is programmed in HTML5 in way that it easily adapts both to PC and last generation tablet/smartphones.

The interface connects the users with this program, providing information about and real time consumption, historical consumption data and peer comparison. All these will be detailed illustrated below with their functional specification, original codes and graphical representation.

3.1 Login page

The login page refers to the credentials required to obtain access to the user's restricted area. Logging in is the process by which individual access to their energy consumption information. Once a user has logged in, they can then log out when access is no longer needed.



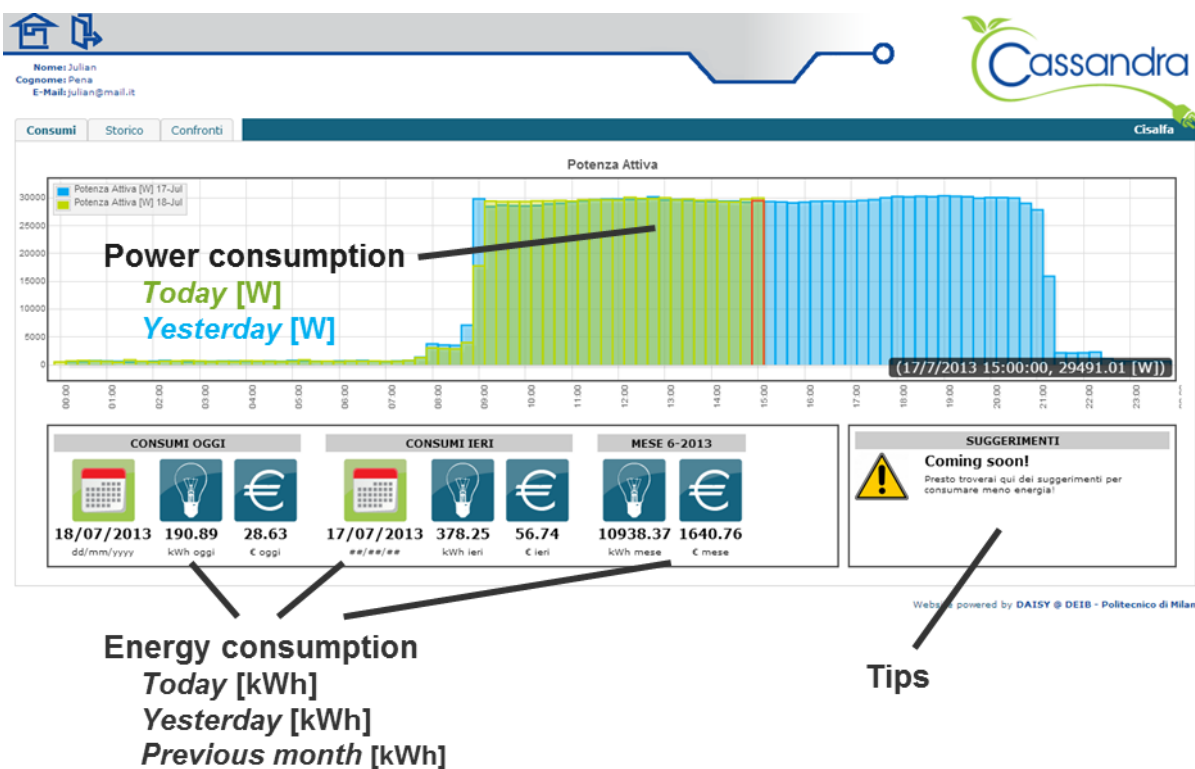
```
//
<body class="body" onload="pageLoad();" >
  </img>
  
  </img>
  </img>
  <div id="peopledata" class="people_data">
    <table cellpadding="-2px">
      <tr>
        <td class="people_data_label">
          <u>Nome:</u>
        </td>
        <td style="text-align: left">
          <label>${user.Name}</label>
        </td>
      </tr>
      <tr>
        <td class="people_data_label">
          <u>Cognome:</u>
        </td>
        <td style="text-align: left">
          <label>${user.Surname}</label>
        </td>
      </tr>
      <tr>
        <td class="people_data_label">
          E-Mail:
        </td>
        <td style="text-align: left">
          <label>${user.Email}</label>
        </td>
      </tr>
    </table>
  </div>
```

```

<iframe id="mainframe" class="main_frame" scrolling="no"
  frameBorder="0" src="/Feedback/shops.html">
</iframe>
<div style="width: 100%; text-align: right;">
  <label style="margin-right:5px; float:right;font-size:10px;color:
  #15637F;">Website powered by <a
  href="http://daisyLab.deib.polimi.it"
  style="text-decoration:none;color:#104b9b;"><b>DAISY @ DEIB -
  Politecnico di Milano</b></a></label>
</div>
</body>
//
```

3.2 Shop consumption page

Shop consumption page shows the daily power consumption profile, compared with yesterday's one and updated every minute. In addition the daily energy consumption in kWh and daily energy cost in € for the present day and the previous one are shown. In the end, there is a box showing tailored tips in order to reduce energy consumption.



Shop consumption page

//

// daily energy

```
function dailyEnergyLoaded(samples)
{
    if(samples.length>0){
        document.getElementById('dailyEnergyTx').innerHTML =
            Math.round(samples[0].value * 100)/100;
        document.getElementById('dailyEurosTx').innerHTML =
            Math.round(0.15*samples[0].value * 100)/100;
        var dateString = new Array();
        dateString = startToday.split("-");
        var year= dateString[0];
        var month = dateString[1];
        var day= (dateString[2].split(" "))[0];
        document.getElementById("dateToday").innerHTML
            = day+"/"+month+"/"+year;
    }
}
```

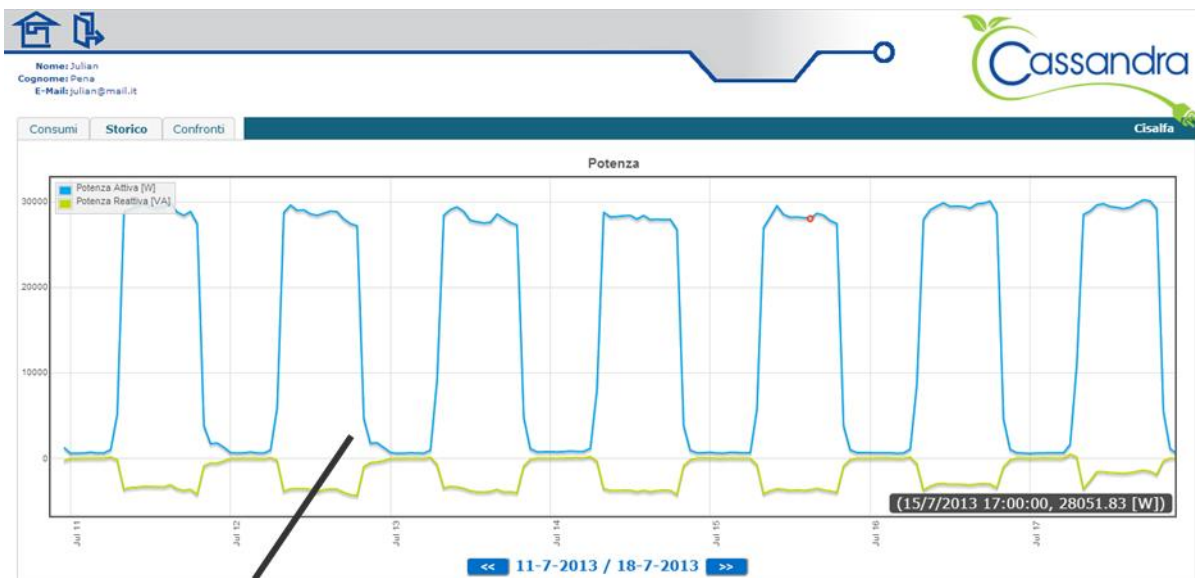
```
// yesterday energy
function yesterdayEnergyLoaded(samples)
{
    if(samples.length>0){
        document.getElementById('yesterdayEnergyTx').innerHTML =
            Math.round(samples[0].value * 100)/100;
        document.getElementById('yesterdayEuroTx').innerHTML=
            Math.round(0.15*samples[0].value * 100)/100;
        var dateString = new Array();
        dateString = startYesterday.split("-");
        var year= dateString[0];
        var month = dateString[1];
        var day= (dateString[2].split(" "))[0];
        document.getElementById("dateYesterday").innerHTML
            =day+"/"+month+"/"+year;
    }
}

// monthly energy
function monthlyEnergyLoaded(samples)
{
    if(samples.length>0){
        document.getElementById('monthlyEnergyTx').innerHTML =
            Math.round(samples[0].value * 100)/100;
        document.getElementById('monthlyEuroTx').innerHTML =
            Math.round(0.15*samples[0].value * 100)/100;
        var dateString = new Array();
        dateString = startYesterday.split("-");
        var year= dateString[0];
        var month = dateString[1]-1;
        document.getElementById("lastMonthLabel").innerHTML =
            "MESE "+month+"-"+year;
    }
}
```

```
//
```

3.3 Historical date page

The page shows an historical weekly chart with active and reactive power profiles.



Historical power consumption

Active power [W]

Reactive power [W]

Historical data page

//

```
<script type='text/javascript'>
    var graph=null;
    var activePower = ${data.activePower};
    var reactivePower = ${data.reactivePower};
    var toDate=new Date();
    var fromDate = new Date(toDate.getTime()-7*24*60*60*1000);

    function onload()
    {
        window.onresize = refresh;
        var container = document.getElementById('powerContainer');
        var series = new Array();
        series[0] = new OptSeries("Potenza Attiva", activePower, "W",
            "lines", null);
```

```

series[1] = new OptSeries("Potenza Reattiva", reactivePower,
"VA", "lines", null);
graph = new HtmlChart(container,new OptChartRel("Potenza",
"simple", "hours", "lastdays", "day", 7, 7),series);
document.getElementById("day").innerHTML = fromDate.getDate()
+ "-" + (fromDate.getMonth()+1) + "-" + fromDate.getFullYear()
+ " / " + toDate.getDate() + "-" + (toDate.getMonth()+1) + "-"
+ toDate.getFullYear();
refresh();
}

function refresh()
{
    // altezza body
    var myWidth = 0, myHeight = 0;
    if( typeof( window.innerWidth ) == 'number' ) {
        //Non-IE
        myWidth = window.innerWidth;
        myHeight = window.innerHeight;
    }
    else if( document.documentElement &&
        ( document.documentElement.clientWidth ||
        document.documentElement.clientHeight ) ) {
        //IE 6+ in 'standards compliant mode
        myWidth = document.documentElement.clientWidth;
        myHeight = document.documentElement.clientHeight;
    }
    document.body.style.width = (myWidth-4) + "px";
    document.body.style.height = (myHeight-4) + "px";
    document.getElementById("powerContainer").style.width
    =(myWidth-20) + "px";
    document.getElementById("powerContainer").style.height =
    (myHeight-60) + "px";
    if(graph)
        graph.drawChart();
    /*
    document.getElementById("tipsContainer").style.width =
    "300px";
    document.getElementById("kpiContainer").style.width
    =(myWidth-370) + "px";
    document.getElementById("datatable").style.width =
    (myWidth-370) + "px";*/
}

```

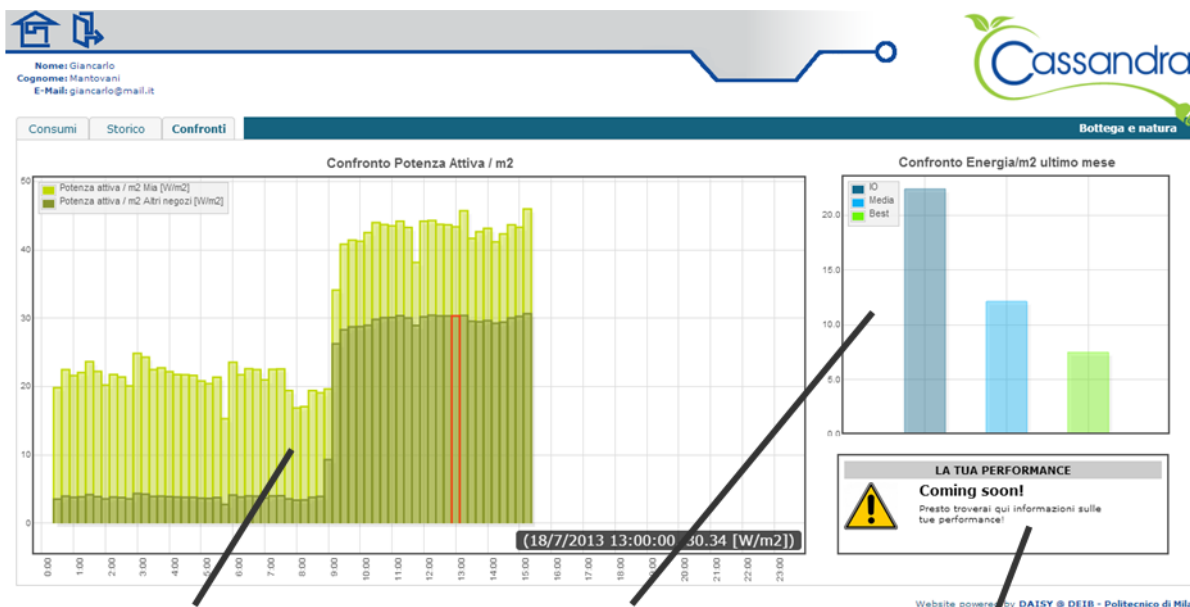
```
function goBack()
{
    toDate=new Date(toDate.getTime()-24*60*60*1000);
    fromDate = new Date(toDate.getTime()-7*24*60*60*1000);
    document.getElementById("day").innerHTML = fromDate.getDate()
+ "-" + (fromDate.getMonth()+1) + "-" + fromDate.getFullYear()
+ " / " + toDate.getDate() + "-" + (toDate.getMonth()+1) + "-"
+ toDate.getFullYear();
    graph.goBack();
}

function goForward()
{
    toDate=new Date(toDate.getTime()+24*60*60*1000);
    fromDate = new Date(toDate.getTime()-7*24*60*60*1000);
    document.getElementById("day").innerHTML = fromDate.getDate()
+ "-" + (fromDate.getMonth()+1) + "-" + fromDate.getFullYear()
+ " / " + toDate.getDate() + "-" + (toDate.getMonth()+1) + "-"
+ toDate.getFullYear();
    graph.goForward();
}
</script>

//
```

3.4 Comparison page

The page contains a chart which compares the power consumption per square meter of each shop with the average power consumption per square meter of the shops belonging to the same category. Then, a second smaller chart which calculates monthly energy per square meter is calculated for the shop and is compared to the average value and the best one of the same category.



Daily power comparison

You [W/m²]
Other shops [W/m²]

Monthly energy comparison

You [kWh/m²]
Average [kWh/m²]
Best [kWh/m²]

Performance
evaluation

Shops comparison page

//

```
function squareMeterMonthlyEnergyLoaded(samples)
{
  if (samples.length>0)
  {
    squareMeterMonthlyEnergyValue = Math.round(samples[0].value * 100)/100;
    sqMetMonEnSeries = [
      {label: "IO", color: "#11698C",
      data: [[1, squareMeterMonthlyEnergyValue]],
      xaxis: 1, yaxis: 1},

      {label: "Media", color: "#05B1F5",
      data: [[2, sameGroupSqMetAvgMontEn]],
      xaxis: 1, yaxis: 1},

      {label: "Best", color: "#6DF505",
      data: [[3, sameGroupSqMetMinMontEn]],
      xaxis: 1, yaxis: 1}
    ];
    if(sameGroupSqMetAvgMontEn>squareMeterMonthlyEnergyValue)
      chartMax = sameGroupSqMetAvgMontEn*1.05;
  }
}
```

```
    else
        chartMax = squareMeterMonthlyEnergyValue*1.05;
        drawEnergyComparisonChart();
    }
}

function drawEnergyComparisonChart()
{
    var options = {
        HtmlText : false,
        title : "Confronto Energia/m2 ultimo mese",
        mouse : {
            track : true,
            trackDecimals : 2,
            trackFormatter : function(obj) {
                return obj.y + " [kWh/m2]";
            }
        },
        legend : {
            show: true
        },
        xaxis: {
            "min": 0,
            "max": 4,
            "noTicks": 4,
            "labelsAngle": 90,
            "showLabels": false
        },
        yaxis: {
            "min": 0,
            "max": chartMax
        },
        bars: {
            show:true, barWidth:0.5
        }
    };

    var energyChartContainer =
        document.getElementById("energyComparisonContainer");
    Flotr.draw(energyChartContainer, sqMetMonEnSeries, options);
}

//
```

3.5 Mobile interface

The mobile interface makes this project easily adapt both to smartphones and tablets. Nowadays, the smartphone is growing very fast and affordable mobile devices have begun to transform every aspect of our societies. Analysts predict that in the future, mobile phones will probably overtake desktop computers as our primary means for accessing the internet. In order to keep pace with this rapidly changing landscape, we also think about mobile as our main project goal.

The image displays two screenshots of a mobile web interface. The left screenshot shows the login page, and the right screenshot shows the main dashboard.

Left Screenshot (7:37 PM): The browser address bar shows `http://192.168.0.2:8080/...`. The page features the 'Cassandra' logo with a green leaf and a blue plug icon, and the 'SEVENTH FRAMEWORK PROGRAMME' logo. Below the logo are two input fields labeled 'Utente:' and 'Password:', and a blue 'Login' button. The 'DAISY' logo is visible at the bottom.

Right Screenshot (10:38 PM): The browser address bar shows `http://192.168.0.2:8080/...`. The page displays user information: 'Nome: Julian', 'Cognome: Pena', and 'E-Mail: julian@mail.it'. There are navigation tabs for 'Consumi', 'Storico', 'Confronti', and 'Cisalfa'. Below the tabs is a section titled 'Potenza' with a legend for 'Potenza Attiva [W]' (blue square) and 'Potenza Reattiva [VA]' (yellow square). A table with 5 columns and 5 rows is shown below the legend. At the bottom, there are navigation arrows and the date range '14-8-2013 / 21-8-2013'.

Nome: Julian
Cognome: Pena
E-Mail: julian@mail.it

Consumi Storico Confronti Cisalfa

Potenza Attiva

CONSUMI OGGI

24/08/2013 0 kWh oggi 0 € oggi

CONSUMI IERI

23/08/2013 0 kWh ieri 0 € ieri

MESE 7-2013

6992.49 kWh mese 1048.87 € mese

SUGGERIMENTI

Coming soon!
Presto troverai qui dei suggerimenti per consumare meno energia!

Website powered by DAISY @ DEIB - Politecnico di Milano

Nome: Julian
Cognome: Pena
E-Mail: julian@mail.it

Consumi Storico Confronti Cisalfa

Confronto Potenza Attiva / m2

Potenza attiva / m2 Mia [W/m2]
Potenza attiva / m2 Altri negozi [W/m2]

Confronto Energia/m2 ultimo mese

Confronto Energia/m2 ultimo mese

Categoria	Valore
IO	~5.8
Media	~7.8
Best	~4.8

LA TUA PERFORMANCE

Coming soon!
Presto troverai qui informazioni sulle tue performance!

4 Project implementation

In this section, it is simply introduced how this project is implemented involving shop owners. With the objective of creating the necessary awareness to the program, in order to make participants aware of the benefits that can be achieved through the application of the program, and give them the motivation, included monetary incentives.

4.1 Program advisement

In behavioural programs like Cassandra project, advertisement and participants' involvement are crucial aspects for maximizing the outcomes and consequent obtained energy savings. In this view, a lot of effort was invested for informing and involving the shops at Campo dei Fiori, making them aware of the objectives of the program and related advantages.

The first activity carried out was the design of a leaflet promoting the program. A lot of attention was paid to the flyer structure and delivered information, mainly:

Program objectives and motivation

Feedback channel (web-interface, with related URL).

Expected impact of similar programs

Contact information and details on how to subscribe. Crucial in order to easily recruit new shops.

Brief feedback program context, namely overall Cassandra project description

Personal visits were performed for leaflets handover: it was a crucial experience in order to see the reactions and expectations of people with the program, which were used to better tailor the interface on their needs.

4.2 feedback and advice

After showing the energy use situation to users, advices are provided along in order to achieve our goal, reducing the energy consumption

Some useful advices and tips are presented below for example:

Heating in winter:

Turn the temperature on the thermostat of your heater or reverse cycle air conditioner lower. Every 1° increase in temperature can increase the heating component of your energy bill by up to 15%.

Install ceiling insulation.

Close curtains/blinds to minimize heat loss.

Seal cracks and holes that cause drafts, which will increase winter heat loss.

Heat only the areas of the area you are using.

Cooling in summer:

Use fans instead of or with air conditioners.

Set the thermostat of your air conditioner higher. Each degree lower can add 10% to the cost of running an air conditioner.

Close windows and blinds during the hot parts of the day to keep the heat out.

Install ceiling insulation

4.3 Monetary incentives

Monetary incentives are a very important lever in order to make the program more effective. Along with advantages that can be reached only with program application, shop owners can have further advantages by exploiting monetary incentives in the context of Cassandra project.

The basic idea is to reward the shops more sensible in reacting to the feedback on the information about their power consumptions and, consequently, demonstrate to save more energy. Incentives are distributed according to two different rankings:

Rank 1: comparison among similar shops

Rank 2: comparison with your performance before program application

In this view, all the KPIs defined will be evaluated for all the participating shops.

The methods and criteria will be defined in detail in the future work.

5 Conclusions and future work

5.1 Conclusions

Increasing energy efficiency is a very important issue in the world nowadays.

With this feedback Cassandra project, the energy consumption is reduced and the efficiency is improved.

The frameworks used in the program are very useful, improving the program developing efficiency.

5.2 Future work

Developing and enriching the project so that it can adapt to other environment

Discussing and defining the methods and criteria for monetary incentives

Studying and improving the commercial building different control strategies for energy optimization and comfort regulations

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